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ARMY INFORMATION DIGEST

OWARD TOMORROW'S ARMY

A Special Research Issue

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HIDDEN IN every new scientific development is an unseen ingredient—the persevering skills of countless research specialists.

The microstill on the front cover is one of their laboratory tools, used to separate and identify chemical agents where the total sample available is less than an ordinary drop. Recent developments of Army-wide significance which have come out of Technical Service laboratories are described in this issue.

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Volume 10

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A Special Research Issue

Toward Tomorrow's Army

a foreword by brig. ge

chief of research an

THERE IS little doubt that today we are living in an era of scientific revolution of even greater magnitude than the industrial revolution of the Nineteenth Century. The impact of this revolution on the Army is apparent if we examine a few facts.

In 1935 our total Army research and development budget was approximately two million dollars annually in contrast to an annual program of about $330 million today.

In 1935 our field artillery was still basically the horsedrawn French 75-mm. Today's artillery is highly mobile and packs an atomic wallop.

In 1935, long-range aircraft detection depended upon acoustic listening devices to pick up the sound of relatively slow-moving aircraft. Today we use radar to detect aircraft flying at supersonic speeds.

The scientific revolution to which I refer has not been confined to this side of the ocean. The Soviets have made very great progress in the modernization of their army by applying the findings of modern science.

World War II repeatedly demonstrated that the nation whose research and development program

ndrew p. o'meara

evelopment

was sufficiently farsighted to permit the introduction of new weapons in quantity—before similar or countering weapons were produced by the enemy—possessed a decisive advantage.

These lessons, coupled with the fact that the United States is in no sense the sole beneficiary of science, provide the urgency which motivates execution of the Army's Research and Development Program.

We must be certain that our Army is more mobile, has greater fire power, better communications, and a stronger capacity for sustained action than anything an enemy could put in the field. We must also make our equipment less complicated, less expensive, and easier to operate and maintain.

I can assure you that we in Research and Development are looking toward tomorrow's Army with our goal the accomplishment of these objectives.

Andrew P. O'Meara

ANDREW P. O'MEARA
BRIGADIER GENERAL, USA
CHIEF OF RESEARCH AND DEVELOPMENT

Unseen—silent—deadly—radioactive contamination must be met with effective

Radiation Detection Instruments

Philip Shapiro

THE THUNDEROUS DETONATION of an atomic weapon is a spectacular, awe-inspiring event. The flash, heat and shock waves which wreak their devastating damage are over in a matter of seconds.

But it is the insidious, silent, unseen after-effects of radioactive contamination that present new and heavy burdens of responsibility on the commander in the field. Is the vital area safe or deadly? Is food and water unfit for consumption? Is equipment contaminated? Are troops ridden with radiation sickness which may prove incapacitating, even fatal?

For the troop commander the entire problem is complicated by the fact that nuclear radiations—even despite the warning of an explosion—are invisible to all the senses. The contaminated area, equipment and food appear the same as usual. Further, radiation sickness is insidious in its early stages but becomes progressively worse. A soldier exposed to harmful levels of radioactivity may not even know he was exposed. He usually has no sensations of illness, yet within a few days he will be in a hospital bed.

Obviously then, a primary requirement for an adequate defense which allows the field commander to operate without exposing his troops, is the development of instruments for determining the intensity and extent of radiological hazards.

SEVERAL such instruments have been adopted and are now in use as a result of the study of nuclear weapons and instruments at the Signal Corps Engineering Laboratories, Fort Monmouth, New Jersey, and at the Chemical and Radiological Laboratories, Army Chemical Center, Maryland.

So that commanders and those who use the instruments may understand them better—both their advantages and limitations—it is necessary to have a basic understanding of atomic energy.

A fundamental law of physics holds that matter and energy can neither be created nor destroyed. In 1905 Einstein postulated his now famous mass-energy equivalence principle that mass could be con-

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verted into energy in accordance with the equation:

$$\text{Energy} = \text{Mass} \times \text{Velocity of Light Squared}$$

Since the velocity of light is 186,000 miles per second, a number well up in the billions results when it is squared. Thus it is obvious that the transformation of a very small mass will result in release of huge amounts of energy.

As an example, consider that ordinary burning of two pounds of coal will release some 8.5 kilowatt hours of energy. But if the same amount of coal could be completely converted to energy as in the equation, it would release about 25 billion kilowatt hours!

ALL this remained in the realm of theory, however, until experiments with atom smashing machines such as the cyclotron, confirmed the validity of Einstein's theory. Early experimenters, in fact, were not quite aware of the true nature of their results. In 1939 it was proved that uranium could be fissioned with the release of large amounts of energy, and by 1942 a nuclear reactor was operated to prove that such action could be controlled and sustained by a chain action to liberate energy continuously.

Three years later the United States had succeeded in producing the atom bomb, thereby opening the "atomic era". In 1952 a new chapter was added when the first fusion detonation—the so-called hydrogen bomb—was exploded at a Marshall Island test site.

The energy resulting from atomic fission or fusion results from the annihilation of a small percentage of the mass in the nucleus of an atom. Such energy is released in many forms during an atomic explosion. The resultant high temperatures and a powerful shock wave cause most of the physical damage to buildings and equipment and are responsible for the majority of deaths and physical injury occurring within a short time after the explosion.

BUT the unseen effects, which are those under discussion here, may be as dangerous—and last longer—than the effects of the actual explosion.

First, a broad spectrum of electromagnetic radiations are released. These range from the deep infrared through the visible and ultraviolet down to very penetrating gamma rays. The infrared to ultraviolet radiations can produce burns and blindness to those who are exposed at the time of explosion. Excessive gamma ray exposure leads to the progressive physical disability called radiation sickness, which may finally result in death.

At the same time, the initial flash of radiations is accompanied by a burst of neutrons, which are nuclear particles having one mass unit and no electrical charge. Again these can cause radiation sickness—and with even greater effectiveness than gamma rays.

DURING the explosion, the heavy atoms of uranium or plutonium disintegrate; and in this process they produce many kinds of atoms of lower atomic weight, called fission products, which are radioactive. They release beta particles and gamma rays as they decay more or less slowly to form

stable isotopes. The beta particles are very high speed electrons released from the nucleus of a radioactive isotope, and exposure can lead to serious skin burns. Inhalation or injection of such isotopes can produce internal radiation damage.

To make this entire picture more complete, the fissionable bomb fuel itself is radioactive, emitting primarily alpha particles in fission product fields. While these will produce serious biological damage if they get inside the body, the fuel remaining after a detonation is so widely scattered that the alpha hazard is not normally considered to be significant.

To summarize: The initial flash of electromagnetic radiations, neutrons and the shock wave all dissipate very quickly, but the fission products release beta and gamma radiations for a long time after the detonation. While it should always be remembered that the initial effects of the blast and heat of an atomic detonation have caused most of the casualties, these lingering after effects can so contaminate terrain and materiel—without changing outward appearances—that they present a great problem to the commander who must decide whether his troops can safely advance over the ground or use the materiel.

JUST HOW significant the lingering nuclear radiation effects may be depends on the type of bomb and how it is used. An air burst, for instance, produces relatively little residual radioactive contamination in the area below the detonation, which is known as "ground zero." There may be some "fall-out" of airborne fission products at some distance from ground zero under some atmospheric conditions, but usually the air burst produces little damage from its nuclear radiations.

But as the altitude of the burst is lowered, the area damaged by blast and heat becomes smaller while lingering radioactive contamination on the ground begins to become significant. A detonation on or just below the surface will produce a highly radioactive crater with considerable contamination in a spreading area downwind from this crater. But shock damage is reduced and heat damage becomes practically negligible.

In the case of underwater bursts, vast quantities of contaminated water are thrown up, to fall back on the surrounding countryside as radioactive rain. Again, as with the surface burst, blast and heat damage are less.

As has already been stated, it is not necessary to explode an atomic bomb to produce much the same effects so far as radiation is concerned. The same after-effects as those produced by the bomb may be introduced in a number of ways to spread fission products or separated radioisotopes over an area. Therefore it now is incumbent upon commanders of ground troops to take precautions against the insidious effect of radiation even though no spectacular detonation may have been set off.

The problem of developing detection instruments was simplified by virtue of the fact that beta radiation always exists together with gamma radiation. Therefore tactical radiation detection instruments need be developed to measure

gamma rays only—and detection of these is relatively simple.

To understand the functions of the new type of instruments identified as Radiac (Radiation Detection, Indication and Computation) a brief summary of the various units of radioactivity is helpful.

Two units are used to indicate how much radioactivity is being emitted from an unstable material in terms of the number of nuclear disintegrations which occur each second—dis/sec. These are the "curie" and the "rutherford."

Since these designations do not give information on the type (whether beta or gamma) nor on the energy of the radiations, such energy is expressed in terms of electron volts.

For evaluation of radiological hazards, another unit is necessary. This is the "roentgen" which is a measure of the quantity of X or gamma radiation that produces a certain quantity of electrostatic charge when absorbed in air. When applied to gamma radiation intensities, they are measured as dose absorbed per unit time—or roentgens per hour.

ANY INDIVIDUAL can absorb three-tenths of a roentgen weekly throughout a lifetime without discernible effect. An acute dosage of over 25 r is required to produce a transient change in the blood; 100 r gives the first signs of radiation sickness; while 400 r will cause death in 50 percent of personnel exposed. The latter is known as the Mid Lethal Dose, or MLD.

RADIAC instruments can be classified into two general types—the "dosimeter" which determines the total radiation dosage; and the "dose rate meter" or "survey meter" which measures the instantaneous radiation intensity at a particular location.

The dosimeter shows what accumulated exposures a group of men have received in a given situation; and this indicates which groups will be militarily effective and which will require evacuation for medical treatment.

The simplest instrument of this type is an interim standard instrument covering the range 50 to 500 r's, known as Radiac Detecting Element DT-65/PD. Worn around the neck like a dog tag, it is enclosed in Film Holder, Ph-656/PD. Its operation is based on the principle that X or gamma rays affect sensitized film—the same factor that led Roentgen to his discovery of X-rays in the first place.

In this item, a photographic emulsion is affected if gamma rays are present. The small unit can be developed and read within one minute, utilizing built-in equipment which eliminates any need for difficult and complicated darkroom processing. A five step comparison gray scale allows quick reading of the intensity of the radiation.

While each film plaque can be used only once, it is relatively inexpensive, costing less than ten cents each to produce. Already machinery capable of manufacturing three million elements a month is ready for use on a standby basis.

Because the DT-65/PD is based on photographic film, a significant drawback is its instability when stored at high temperatures. To eliminate this, a quartz fiber dosimeter, Radiacmeter IM 93/UD, now is undergoing service testing. About

the size of a fountain pen, it gives a continuous reading from 0 to 600 r.

This unit operates on the principle that gamma rays ionize air through which they pass. The detector consists of an inclosed air volume containing two electrodes. An electric charge, previously placed on the two electrodes, is ionized, and this charge is easily read in terms of the displacement of a quartz fiber magnified by a built-in optical system.

Such dosimeters have existed for many years but have not always been 100 percent accurate. In contrast, the IM–93/UD is extremely rugged. It also is more accurate and more resistant to radiation degradation despite its significantly lower cost as compared to previously available units.

Since the quartz fibre dosimeter uses an electrical charge, it is necessary to put an initial charge into each one. To accomplish this Radiac Detector Charger PP–995/PD has been developed and soon will be available. Powered by a single flashlight battery, it can charge any number of dosimeters. This unit is the culmination of a long series of tests and changes, and is lighter and cheaper than previous types.

THE Hydrogen Age found the Army with no dosimeter in the hands of its troops. To fill this critical need, the Chemical Corps rapidly developed and issued a device which measures radiation dosage by a chemical reaction. This ElR3 tactical dosimeter is not a standard item, but is the only instrument available for issue at this time.

The items described above are expected to meet all current military requirements for tactical dosimeters. However, when a qualitative picture of the extent of radioactive contamination of persons, equipment or materiel is required—which will enable the commander to determine when occupation of contaminated areas will be feasible—then more complicated survey or dose rate meters are necessary.

DOSE rate or survey meters are classed, according to the nature of the radiation detector, as Geiger-Muller, ionization chamber or scintillation types.

The Geiger-Muller instruments have been widely described and are known to the public as the type used by uranium hunters. They register radiation with a characteristic clicking or buzzing.

Ion chamber survey meters operate on the same principle of gas ionization as the quartz fiber dosimeters. Here, however, a constant electric potential is impressed on a two-electrode gas chamber. The ionization current produced in this gas by the nuclear radiations is collected, amplified and measured. High value resistors and a special electrometer vacuum tube are employed in the measurement of low currents.

This type of instrument is most suited for tactical field use. It has now been developed to the point where small, reliable portable devices are in production or soon will be standardized. Currently available is Radiac Set AN/PDR–39, a rugged, accurate meter with a five decade color-coded scale covering the intensity range from 0 to 50,000 mr/hr.

While this set has proved its worth in tests both in the Marshall Island and Nevada Proving Grounds, a new instrument, Radiacmeter IM–70/PD, is being developed. Although serving the same purpose, it will be only about a third as large and heavy and cost about half as much. Service testing now is proceeding and procurement is expected soon.

FOR wider distribution among tactical units, a simplified Radiacmeter IM–108/UD has been developed which is small, light and cheap to manufacture. Two types are under study. Model XE–1 is flat, rectangular, seven inches long and three inches wide, weighs about a pound and can be worn around the neck like a binocular. The XE–2 model is L-shaped so that it can be worn attached to a standard waist cartridge belt.

Service testing on the two models now is being carried out. All in all, the IM–108/UD appears to meet all military requirements for a rugged, tactical dose rate meter for general radiological defense.

While these various instruments cover the Army's requirements for portable radiac instruments, situations may arise where it is necessary to determine whether a particular water or food supply is safe, the extent of airborne contamination, or the effectiveness of decontamination operations on equipment or installations.

Because this involves measuring with extreme accuracy low levels of alpha and beta, as well as gamma activity, more complex equipment and facilities are required.

For such requirements, a completely equipped and self-sufficient Chemical Mobile Laboratory (M3) has been standardized by the Chemical Corps. Housed in a 26-foot trailer, it can be moved close to the contaminated area and quickly put into operation. Trained teams enter the area, collect appropriate samples of air, liquids or solids, then rush them back to the laboratory for processing in the radiochemical section and measurement in the counting section.

WITH the aid of such devices the Army is well advanced in its capabilities for measuring radiation hazards in event of an atomic war. But research and development continues. New radiac techniques using luminescent, photovoltaic and photoconductive detectors are being studied with the aim of simplifying field survey meters even further. In every aspect of its operations the Signal Corps Engineering Laboratories are aware of the implications of the expanding atomic weapons technology, and are prepared to meet the new problems as they arise.

Like the stage magician, the Transportation Corps is working wonders with a "magic black box" that provides

Transport Without Wheels

Colonel Charles A. Nebel

ONE of the most amazing pieces of transportation equipment now being used by the Transportation Corps has no motive power of its own; it cannot float nor fly, and what is most unusual, it has no wheels. Yet this incredible device is daily transporting thousands of tons of Army cargo in ever increasing amounts from depots, posts, camps and vendors' plants all over the United States to destinations in the Far East, Europe, Alaska—wherever American troops are stationed overseas.

This item is known by the prosaic and certainly uninspiring name of Cargo Transporter. It is nothing more than a rather plain and simple steel box that looks like a cross between an old fashioned packing crate and a light safe. Sometimes it is referred to as a "magic black box" because of the new tricks in cargo carrying it is constantly working, often to the wonderment of logistics experts. Yet this box is symbolic of a whole new concept in military shipping known as "Container Express" or CONEX.

CONSIDERING what has already been accomplished in speeding shipments and slashing costs, as well as its future potentialities, the Cargo Transporter may rightly be regarded as a logistical weapon in a growing and increasingly complex military system.

True, the Army has reduced the existing system of packing, crating and shipping to a science which has already cut costs tremendously, but with the employment of the Cargo Transporter these methods can be made still more efficient.

Consider as an example the movement of a large unit, such as was accomplished recently in the exchange of divisions and Regimental Combat Teams in Operation Gyroscope. Ordinarily the equipment, both military and personal, of the unit involved would be packed and crated in thousands of boxes—office equipment, records, clothing, household goods and the like. The result is a mountain of supplies which must be moved from home stations through ports, onto ships, through overseas ports and then finally to new stations.

Normally each box or crate must be marked and handled individually. It is inevitable under such a shipping procedure that the material of one company will become mixed in shipping—either en route,

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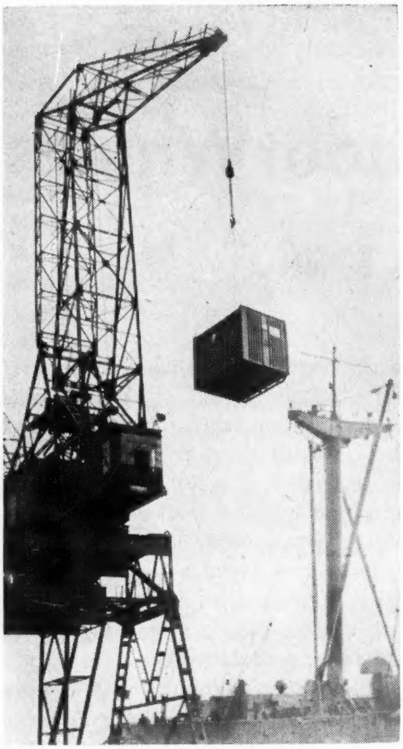


One steel container obviates use of a sling to handle numerous small packages, as was demonstrated in Operation Gyroscope.

on the piers, or in ships—with those of other units. It is extremely likely also that there will be breakage and that some equipment will be damaged or lost. Even assuming that none of these eventualities occur, the job of keeping track of the various items would require many thousands of clerical man-hours.

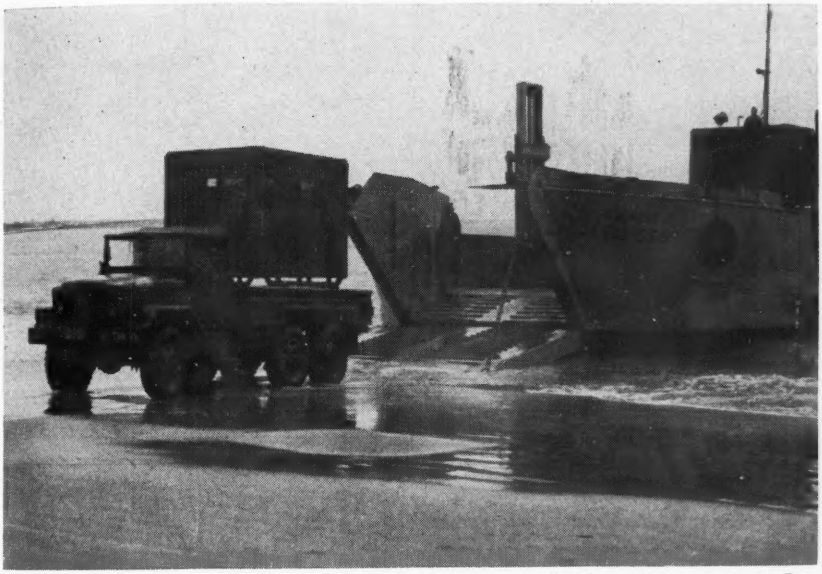
IF THIS is true in a more or less routine peacetime shipment, consider what usually happens in time of war, when tremendous volumes of material and equipment are pushed onto beaches or hurriedly crammed into warehouses. During the Normandy invasion, for example, much necessary and even vital equipment lay at the bottom of piles in warehouses, or could not be properly identified because of obliteration of markings. In the Pacific as well as in Europe conditions were often rendered difficult because of weather and heavy loss through damage and pilferage.

From the supply standpoint, any method that will obviate confusion in packing and shipment may truly be considered a logistical weapon. In time of war especially it is essential to get material over beaches and through ports and forward to the fighting units intact, identifiable and ready for use.

IN an effort to solve these problems the Transportation Corps in 1947 began research into the possibilities of developing a container which could utilize to the fullest extent the latest in mechanical handling equipment—a unit that would weigh no more than five tons when loaded, yet would be suitably sized for movement by various transportation facilities.

Desirably, such a container should be weather and pilfer-proof, and its contents readily identifiable so as to drastically reduce the volume of paper work. If possible, the container should be not only more efficient but less costly to operate, and it should provide its own storage facilities so as to eliminate many existing beach hazards.

The answer was the development of the present steel box or Cargo Transporter, now beginning to be a common sight in Army terminals and ports throughout the world. Cargo Transporters underwent exhaustive testing in Operation ODEX—an over-the-beach ex-



Various methods of moving the containers over the beach were tested in Operation Odex.

ercise between the United States and a typical beach in Europe—as well as in Operation Gyroscope.

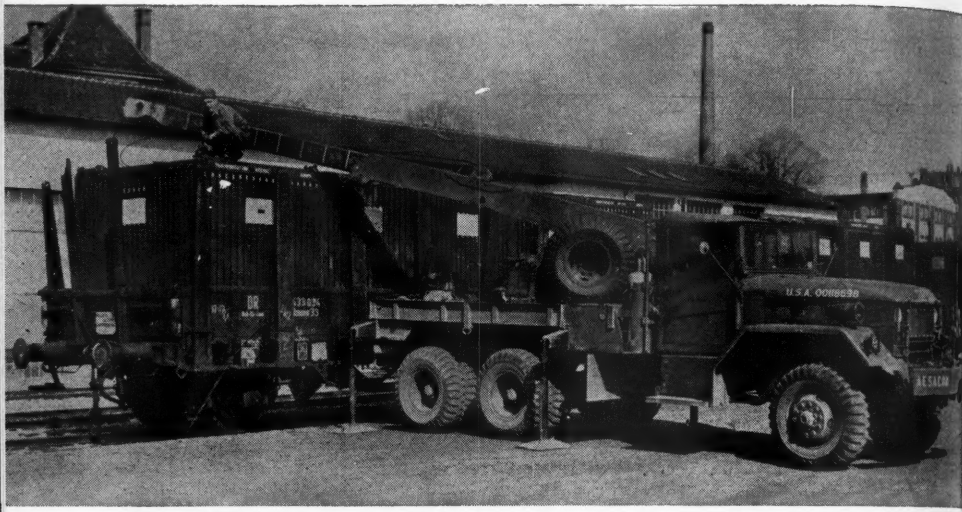
When using Cargo Transporters, each unit of a large organization can pack its own equipment, mark it properly and thus be assured that it will arrive intact at its destination. The containers can be shipped direct, without having to be handled at various depots, so that in many instances they travel right with the unit; or they can be sent ahead so that records and necessary equipment are waiting for troops upon arrival.

DIMENSIONS of the Cargo Transporter are impressive. Each is 8′ 6″ long, 6′ 3″ wide and stands 6′ 10½″ high, grossing 365 cubic feet with a weight of 1500 pounds. Each transporter has a capacity of 9000 pounds in 295 cubic feet.

The container is fitted with skids with openings for fork lift prongs. At all four corners at the top are lifting rings so placed that they do not extend above the top level. Thus the huge container can be stacked easily with the use of standard fork lift trucks or crane booms of suitable capacity.

Access to the inside is by means of double doors placed at one end. Destination and other shipping data are stenciled on address plates provided on all four sides.

Because of its standard uniform shape, the Cargo Transporter can easily be transported by truck, rail or ship. Individual units can be carried in an Army 6x6 truck. Three can be carried in the usual military or commercial flatbed or open-top semi-trailer. From six to eight can be placed on various sized flat or gondola railway cars used in the United States and in many oversea areas.



Cargo Transporters are easily loaded onto flatcars with cranes and lifting equipment now in use.

The units are easily moved ashore by landing craft, lighters or amphibious equipment. Since they are capable of being stacked three high, they can form their own storehouses on beaches, inland depots or intransit areas. They are weather and pilfer-proof and can be made waterproof, if necessary. From an economic point of view, they can and have reduced overall shipping costs substantially when compared with the conventional wooden crate and container.

AT FIRST glance it might seem that the cost of providing these steel packing cases would be comparatively high. But when it is considered that each one will give a minimum of five years of service and that at an original cost of $300 this brings the outlay down to $60 per year plus a small maintenance cost—in other words, about twenty cents a cubic foot—this factor does not loom so large.

When it is further considered that the average wooden case of 2.342 cubic feet cargo capacity costs a little more than $2.50—that is, more than $1 per cubic foot—and that supplies can be shipped in Cargo Transporters without expensive wooden over-packing, then actual savings become apparent.

On one Cargo Transporter load of 240 cubic feet, actual savings over wooden packing amounts to some $200. At this rate it does not take long for a steel Cargo Transporter to pay for itself many times over.

FURTHER savings are gained in shipping weight. In a recent logistic support problem at Fort Eustis, a representative shipment of mixed supplies was withdrawn from the 97 various conventional wooden cases in which it had been packed. All of the items together made a full load for a single Cargo Transporter. The 97 wooden cases had a gross volume of 385 cubic feet (compared to 365 for the trans-

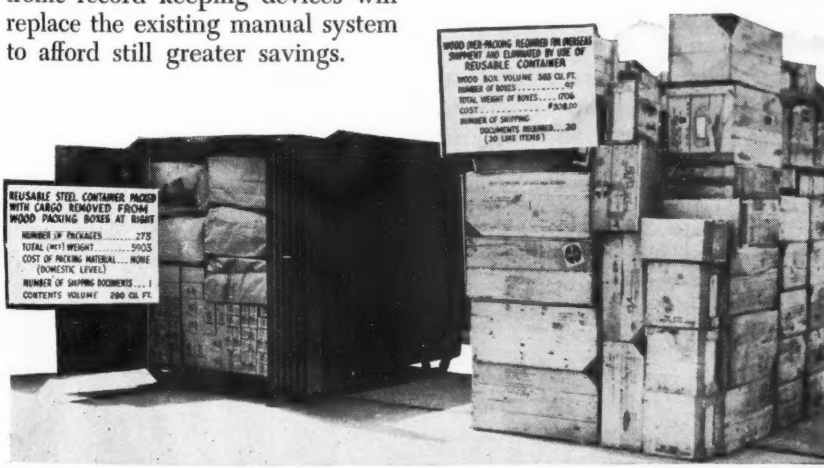
porter) and a tare weight of 1706 pounds (compared with 1500 for the steel box). Moreover the wooden cases cost $308 for labor and materials—or more than the original cost of the steel container.

Other savings can also be enumerated, not the least of which is reduction in paper work. Only one shipping paper is required for a full cargo container, compared to the many necessary for, say, the 97 boxes or crates used in the support problem at Fort Eustis.

AS STILL another significant advantage, the serial number, contents, ultimate destination and present location of every transporter anywhere in the world is a matter of continuous record through a centralized control system maintained in the Office of the Chief of Transportation. Thus if one is lost at sea, or goes astray for any reason, its contents can easily be checked and replaced. It is contemplated that as use of the Cargo Transporter increases, installation of electronic record keeping devices will replace the existing manual system to afford still greater savings.

No problems are being encountered at present in the retrograde movement—that is, return shipment—of the transporters because they are largely being used to bring back household goods, APO mail and other supplies, and the volume of this class of cargo is constantly increasing. Conceivably in wartime some might have to be returned empty but this is not foreseen as a problem since most vessels returning from an active war theater would have empty holds.

The United States Air Force has been quick to appreciate the advantages of the transporter, and has joined forces with the Army in ordering a large quantity. Present plans call for the creation of a joint Army-Air Force CONEX Control Agency to monitor and administer a combined transporter fleet of over 17,000 units to be achieved by the end of 1955, with the next objective of 50,000 transporters within the near future.



Comparison of boxes necessary to package the same amount of goods shows graphically the savings that can be effected by steel containers.

Full implementation of the CONEX operation plan depends on procurement of sufficient transporters and the expansion of facilities for handling them at ports and other installations. Over 5000 transporters are now available and 10,000 additional units are expected to be delivered by December.

BRIEFLY, the entire CONEX plan calls for increasing the speed, safety, accuracy, flexibility and economy of supply operations through controlled movement of cargo in the new Cargo Transporters. At present the Office of the Chief of Transportation is drawing up plans, techniques and operating methods for greater cooperation between Chiefs of Technical Services, commanding generals of oversea commands, and continental armies, commanding officers of depots, ports of embarkation and others, to utilize this speeded-up system.

It is envisioned that the flexible and accurately controlled supply system now being worked out will lead to elimination of old concepts under which supplies have been slowly pumped through successive reservoirs and distribution points, finally to trickle through to users some four months after the initial request.

Controlled movement in transporters can achieve prompt, direct shipment and assured, safe and timely delivery of supplies to users. This in its entirety is being considered as a new concept known as Fluid Dispersion. As described in doctrine recently formulated by the Transportation Corps, Fluid Dispersion is "a logistical concept based on maintaining minimum theater stocks in highly mobile form with exploitation of modern means of transportation and communication to keep supply responsive to operating requirements.

"Fluid Dispersion is in direct contrast to current logistical concepts based on echeloning of large stocks of supplies in depth over the Line of Communication to protect against possible interruptions to transportation and communications. It has been described as an essential logistical complement to modern advancing concepts of strategy and tactics."

CONEX service in general and the Cargo Transporter in particular have fully proven themselves as practical instruments of this new theory of Fluid Dispersion. While the Cargo Transporter is nothing more than a "plain old steel box" it has become in fact one of the most flexible and fastest moving vehicles of transportation even though it has no motive power of its own, cannot float, is incapable of flying and, most unusual, has no wheels.

Limited numbers of extra copies of this special Research and Development issue of ARMY INFORMATION DIGEST are available by requisition through normal AG publications channels.

Global requirements set the fashion in

Field Uniforms for Combat

Robert L. Woodbury

IN HOT-DRY, cold-wet, and temperate climates as well, the operational effectiveness of the soldier is largely dependent upon the degree to which his clothing protects him against the stresses imposed by his environment. Unless he is adequately protected, he must divert attention from his combat task to the rudiments of personal survival. In so doing, he delimits his contribution to the success of his military mission.

If maximum effectiveness is to be achieved, new design principles for clothing ensembles must be developed which will widen the range of environmental conditions under which the field soldier can operate satisfactorily. Clothing items, too, must be properly integrated with the operational equipment.

In the U.S. Army, the distinction between parade and combat clothing was not made until the Spanish-American War. (See "From Homespun to Army Green," December 1954 DIGEST.) Similarly, the need for different solutions to clothing problems in differing environments was not fully recognized until World War II, when the first real utilization of scientific principles and talents was applied to cope with conditions of global warfare.

MANY of the basic problems attacked during World War II are still of current interest. In its approach to these problems, the Army recognizes the need for different environmental clothing ensembles for four major sets of conditions. These problem areas fall into two major categories—those in which the elimination of surplus body heat is the main problem, and those in which the conservation of heat is important.

In the first category the most severe problem, that in which the presence of any clothing interferes with heat loss, occurs when the air temperature approaches that of normal skin and humidities are high. The second hot category, in which clothing is essential to provide shade on the skin, occurs when air temperatures are well in excess of skin temperature and solar, reflected and re-emitted radiation add materially to the heat energy received by man.

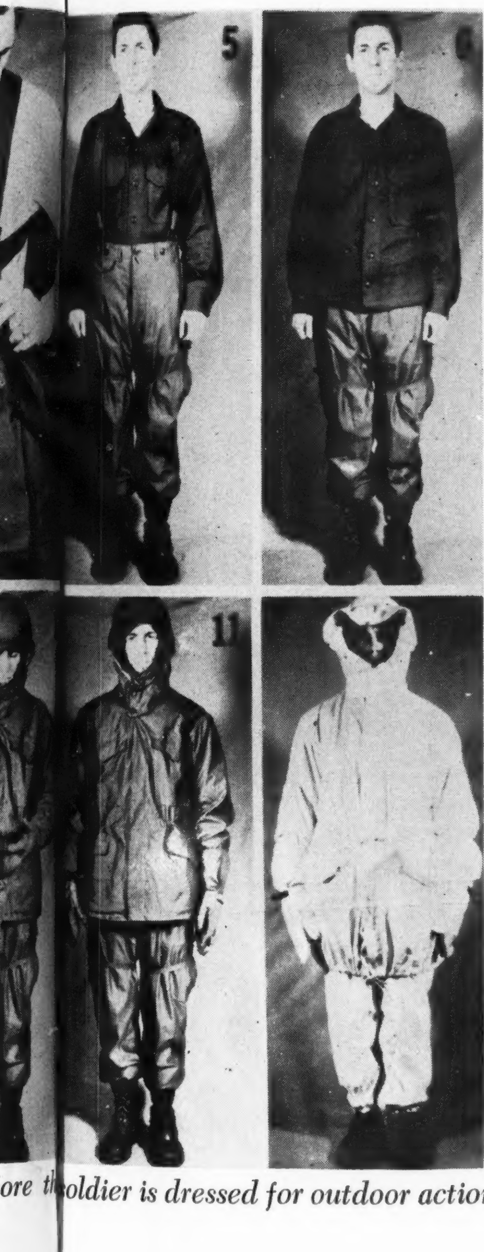
The second major group, that of cold environments, can similarly be broken down into two quite different sets of problem conditions. The first of these occurs when air tem-

ROBERT L. WOODBURY is Chief of the Operations Programming Office, Textile, Clothing and Footwear Division, Quartermaster Research and Development Command, Natick, Massachusetts.

WET COLD COMBAT

The new wet-cold combat uniform requires 12 stages before th soldi

BA UNIFORM



ore th oldier is dressed for outdoor action

peratures are within approximately 20° F. either side of freezing, and moisture in some form is present to an extent that the effectiveness of clothing insulation is seriously impaired. The second cold problem area occurs when temperatures stay well below freezing for long periods of time, making hazardous any exposure of bare skin. This necessitates special protection to the head and face.

In all four of these problem situations, other hazards are also present and compete with environmental protection. The effects of various weapons and the necessity for protection against observation, both by direct vision and through detecting devices, for example, influence the extent to which adequate protection can be developed.

COLD WEATHER ENSEMBLES

POSTWAR progress in the design of cold climate body clothing resulted in the standardization of a new cold weather ensemble in 1951. Currently, new material-design concepts for cold weather apparel are being considered which are based on unconventional approaches to insulation. Also, clothing made of various types of synthetic unicellular resins for specialized cold-wet activities has been developed and is under study. (See "What's New in Vapor Barrier Clothing," July 1952 DIGEST).

Progress has also been made, although to a lesser extent, in improved handwear and footwear items where the layering principle used in body clothing is more difficult to apply. An improved three-component Arctic handwear system has been developed to the

service test stage. The new items increase dexterity and flexibility over the standard system with no loss in insulation.

A cold-wet combat boot, incorporating non-wettable sealed-in insulation, was standardized in 1951. This same principle is being applied in the development of a cold-dry boot to replace the Mukluk and Felt Boot currently in the supply line.

HOT WEATHER CLOTHING

AT THE other climatic extreme, standard hot weather clothing has been found to be unsatisfactory because it does not meet color and functional requirements. Experimental ensembles, each designed for a different type of hot weather, have been developed and are currently being service tested.

Problems in this area have been

Various types of hot weather uniforms are exposed to intense desert heat. Here a test platoon marches up a sand dune at Yuma Test Station.

Less marked advance has been made in protection for the head. Normally the introduction of adequate cold weather insulation about the head tends to impede hearing and raises the problem of integrating such insulation with helmet, earphones, binoculars and other items of equipment. A complete restudy in this area is under way. Prototypes of new headgear, such as integrated environmental-ballistic helmets, are being developed.

brought into sharp focus in recent tests. During 1953, engineering design tests were conducted at Yuma, Arizona, Fort Lee, Virginia, and Panama on three experimental hot weather ensembles and the standard Jacket and Trousers, Lightweight, developed originally for jungle conditions. Each of the experimental hot weather ensembles was specifically designed for a different type hot weather area. Camouflage tests confirmed the re-

quirement for a green uniform in hot-wet conditions and a khaki for hot-dry conditions.

SIZE AND FIT FACTORS

INCREASINGLY since World War II, development work has emphasized the importance of the fit of combat clothing in relation to its functional performance. Three vital factors largely affected by fit are insulation, ventilation, and freedom of movement. The degree to which these three are balanced with other combat requirements largely determines the soldier's effectiveness under battle conditions.

Various means designed to keep the number of sizes of any one item of clothing in the supply system to a minimum, can help reduce logistic support requirements. Before World War II, individual items of combat clothing were designed independently without reference to any system. Later, on the basis of anthropometric data collected by measuring men as they were discharged from the Army, the weaknesses of the existing conception of required size intervals and ranges were uncovered. It was found that the number of sizes used was greater than was actually necessary.

As one result, the cold weather uniform ensemble, designated M–1951, was developed. This ensemble—the first integrated and functional clothing ensemble to be adopted by any army—is based on scientific anthropometric data, and employs a sizing system applicable to all the components. A nine-size system similar to that developed by the Army Quartermaster Corps, incidentally, has been adopted by Canada and the United Kingdom.

Mid-winter tests of the Quartermaster-developed arctic uniform were conducted at Fort Churchill, Canada.

FOOTWEAR DEVELOPMENTS

A POSSIBLE reduction in the

number of footgear items, and consequent reduction in sizes, may result from current development of an experimental cold-dry boot to replace the mukluk and felt boot. This would make possible the replacement of multiple types of sockgear, now worn with both boots, with one pair. An experimental stretch nylon-wool cushion-sole standard sock, which could be issued in three sizes instead of the existing eleven, is scheduled for test this winter. These developments alone could ultimately mean a reduction in the number of line items of sockgear from twenty to three.

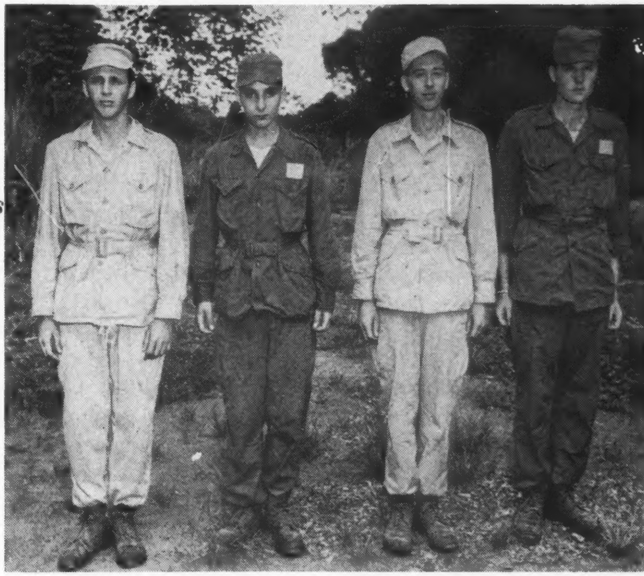
The new experimental boot has the formal name of Boot, Combat, Rubber, Insulated (Dry-Cold). If pending tests lead to its standardization and issue as a replacement for the Standard Boot, Mukluk, this item would require only one sock (cushion sole) instead of the Mukluk ensemble which calls for three pairs of wool socks, one pair of felt socks, and two pairs of felt insoles. The new boot is white to distinguish it readily from the black standard insulated boot, as both have practically the same exterior structure and weight.

HANDWEAR INNOVATIONS

In the handwear field, it has been found that the present standard two-layer system of cold-dry handwear (consisting of Mitten Insert, Trigger Finger M 1948 plus Mitten, Arctic M 1949 with snapped-in wool pile liner) creates a dexterity problem when firing weapons and handling equipment because the insert does not give adequate protection when the mitten is removed.

To solve this, a new experimental three-layer arctic handwear ensemble has been developed. Three

In efforts to improve cold weather handwear, this experimental Arctic Mitten Ensemble now is being tested.



Among types of uniforms field tested in Panama are, left to right, the hot-dry tan, hot-wet green, lightweight tan, and lightweight green.

components are utilized—Mitten, Arctic, T 54–8; Mitten, Windproof, T 54–9; and Mitten Insert, Trigger Finger, T 54–3. (*See illustration*).

The mitten shell, or outside layer, redistributes the insulation so that there is an extra thickness on those portions of the hand which are on the outside and thin insulation on the inside when a fist is formed. Thus the rate of hand cooling is changed according to the surface area exposed to the cold when the soldier opens or closes his hand.

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IN THE multiple fields of clothing requirements for combat, the Army Quartermaster Corps is applying a yardstick of efficiency and effectiveness, while at the same time adjusting its course to the demands of modern logistics. Too many varied items for specialized activities, it is realized, could easily bog down the entire supply system. Many of the uniforms now in use or eventually to be in the supply line, must therefore be made to serve under many special conditions not directly provided for by the clothing designer.

Thus in clothing as in other supply fields, the Army Quartermaster Corps keeps its design and planning flexible, geared to immediate needs yet capable of all-out expansion to meet the logistical requirements of global war.

Engineers at the Waterways Experiment Station seek to tame hydraulic forces in the immemorial battle of

Men Against Wave and Water

Major G. B. Fenwick

A DEVASTATING flood is causing havoc—a river mouth is silting up to endanger navigation—tidal action interferes with smooth operations of a harbor—all of these and many other situations create a wide variety of problems for the Corps of Engineers.

Some of them, like a flood, are tense, dramatic, thrill-packed situations which receive front page attention. Others are seldom heard of. But all are of vital interest to the entire public as well as to the military.

One aim of the Engineers is to eliminate causes of the front page news by prevention, or at least control, of the natural forces causing them. But before any actual work can be done by men in the field, a vast program of scientific research and development is necessary. An important phase of this research is carried on at the Hydraulics Laboratory of the Waterways Experiment Station, Vicksburg, Mississippi.

This laboratory is one of the four major facilities at the Station, which functions under direct control of the Chief of Engineers. The others include the scientific fields of soil mechanics, concrete, and flexible pavements. The Hydraulics Laboratory, for its part, conducts basic studies and experiments in hydraulic design and analysis so necessary to the civil and military construction activities of the Engineers.

WORK of the Hydraulics Laboratory falls naturally into six general categories or specialized fields:

- Regulation of inland waterways for purposes of flood control or navigation.
- Investigation of problems in tidal estuaries.
- Investigation of the performance of hydraulic structures.
- Study of wave-action problems in harbors.
- Determination of effects of underwater military explosions.
- Development and standardization of design criteria for hydraulic structures.

The Laboratory findings have wide applications that go far beyond such activities as flood control, navigation, or power development. The bulk of its investigations represent a wide variety of complex hydraulic design problems.

MAJOR G. B. FENWICK, CE–USAR, is Chief, Rivers and Harbors Branch, Hydraulics Division, Waterways Experiment Station, Vicksburg, Mississippi.

The Laboratory also carries on an extensive investigational program of a classified nature in connection with certain military projects having hydraulic aspects.

Subject to authorization of the Chief of Engineers, services of the Waterways Experiment Station also are made available to other agencies, foreign governments and private firms. All such work is performed on a reimbursement basis, with the sponsor paying all costs.

THE Hydraulics Laboratory conducts engineering investigations principally by the use of hydraulic models. These range in size from small replicas of gates or valves to the world's largest hydraulic model which when completed will be a 200-acre reproduction in miniature of the entire Mississippi River and its tributaries.

By use of such models, the scientists—of whom there are some 20 engineer-specialists and about 100 engineer and technician assistants —can reproduce in miniature, for close study, a flood on a tributary of the Mississippi, tidal or silting action in any harbor that may be a problem, the flow past the power intakes and scenic-improvement works at Niagara Falls, actions of a towboat approaching a lock, the effect of water flow and storm waves on breakwaters and revetments, or virtually any problem involving waterways and tidal action.

In this way engineering specialists can procure fore-knowledge as to how structures will function, thus obviating much useless large-scale construction. They can develop new designs and correct faulty ones before projects are launched. Already such studies have effected savings many times greater than the costs of the research involved and have assured effective functioning of the structures in nature.

The Laboratory utilizes a 40-acre tract of a highly developed model area at Vicksburg, as well as the huge Mississippi Basin Model and other special test installations at the Jackson, Mississippi, Sub-office of the Waterways Experiment Station. Additional tracts are available at both sites.

At Vicksburg the area is well equipped with reservoirs, pumping plants, water-supply systems and utilities. The area contains eight large shelters and the permanent headquarters of the Laboratory personnel. Complete shops and skilled technicians are available for all necessary construction work. A staff of instrumentation specialists develops and maintains the complex equipment.

To supplement and advise the technical staff, the Laboratory also has consultant contracts with several leading scientists at major universities. Conferences are scheduled as necessary to discuss especially complicated problems and to keep abreast of broad scientific progress in its own and related fields of investigation.

DEPENDING on the problem involved, it has been found that considerable money can be saved by building certain models to a planned distortion. In engineering parlance, "high scale distortion" means that the vertical scale is considerably larger than the horizontal. Distortion of this type is for the purpose of magnifying depths so that depth variations are large enough to be measurable without

getting a model of impracticable areal extent.

Some models are of the "fixed bed" type—that is, based solidly in concrete—while others are "movable beds." In a movable bed model, the material forming the bed of the stream or harbor or estuary is fine sand, coal dust, finely ground plastic material, or some such material which is moved about by the action of the water as is the sand or mud forming the beds of natural bodies of water.

FLOOD CONTROL, NAVIGATION

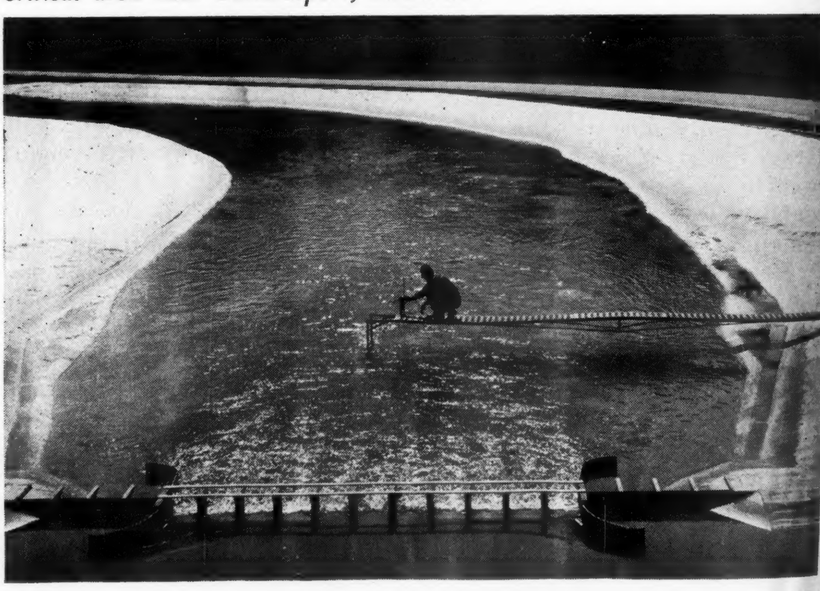
SO LONG as there is rain that falls to earth to drain into rivers, there will be flood problems. Among the first attempts at control to protect life and property was the rather obvious method of building levees.

However, prevention of damage through control of water flow in the upper reaches of streams frequently can do more to alleviate floods than building higher and higher levees. Because such a conception means working at distances beyond the local jurisdiction, some agency above the local or state level is indicated—and this gigantic task has been assigned to the Corps of Engineers.

Flood control problems that demand investigation and solution include not only levees and floodwalls but designs for improving carrying capacities of stream channels; designs of floodways or by-passes to divert flood-waters; and development and operation of reservoirs or other methods to retard runoff from tributaries.

Fixed-bed models with high scale distortion are used extensively to study flood control measures on the Mississippi River and its major tributaries. The model of the Missis-

This model aided in controlling flows from the Mississippi River in a critical area near Simmesport, Louisiana.



sippi Basin now under construction will allow study of coordinated plans all through the huge area, or of any part such as a tributary.

STREAMS that flow through urban and industrial areas present special problems. Here the size and shape of the channel and existing construction such as bridge piers, docks, and so on, all have their effects during high water. Extensive damage can result from a flood in such areas. Fixed-bed models with little or no scale distortion are used to study such hydraulic phenomena as shooting flow, standing waves, backwater effects of channel obstruction and hydraulic jumps.

The Station's model of the Niagara River and Falls was used to develop plans for diverting water for power generation. At the same time, by improving the remaining flow across the crest, the natural scenic beauty of the Falls was enhanced.

Closely allied with flood control is navigation of inland waterways. Models are used in studying plans for increasing or maintaining navigable channel depths by means of spur dikes, training walls or other structures.

The value of such miniatures in navigation improvement is demonstrated in the model of Greenup Locks and Dam on the Ohio River. This was used to arrive at the best arrangement of locks and walls to eliminate such hazards as cross currents and eddies in and near the approaches. A self-propelled, radio-controlled model towboat was employed so that actual "navigation" could be accomplished.

TIDAL ESTUARIES

NOT ONLY river mouths but

Model studies of Niagara River helped provide water for power, yet enhanced the natural beauty of the famous Falls.

canals, harbors and navigable channels present problems in this category. Action of the river and of tides may cause silting, whole beaches may shift, salt water and industrial wastes may cause pollution, tides and currents may endanger shipping.

In studying such problems it is often necessary to reproduce to scale in tidal models such interrelated hydraulic or sedimentation phenomena as tides and currents, wave action, littoral currents, movement and deposition of channel shoaling material, movements of sand beaches, and intrusion and mixing of salt water or industrial pollution. To simulate complicated tide effects, an electro-mechanical device has been developed at the Experimental Station to reproduce the tides of nature with close precision.

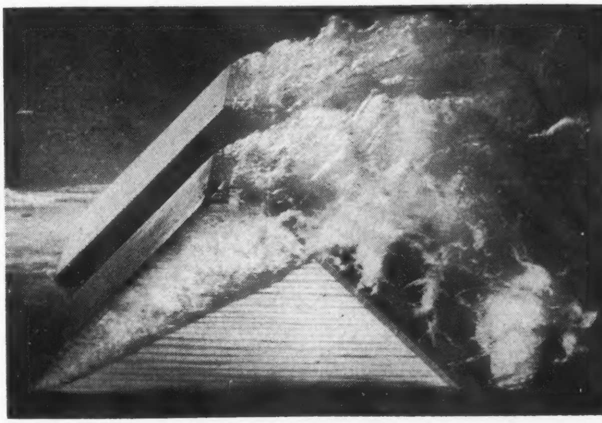
HYDRAULIC STRUCTURES

MODEL studies of hydraulic structures are widely used to investigate design performance of dams, spillways, stilling basins, outlet works, sluices, control gates, high-pressure valves, locks, pumping plants, sewer systems, surge tanks, dry docks and others.

Because the free fall of water is usually involved, structural models used in this area of investigation generally must be built to an exact scale. Often it is found that two or more models of different scales give best results. A large-scale model of limited critical portions is used for determining local effects of design details, while the over-all performance of the entire structure can be evaluated by a smaller scale model.

An interesting feature is the use of transparent plastics materials

Special features of hydraulic structures are studied, as in this reproduction of a spillway of Pine Flat Dam on Kings River, California.



Variable pressure water tunnels allow study of cavitation (vacuum effects) characteristics of baffle-piers.

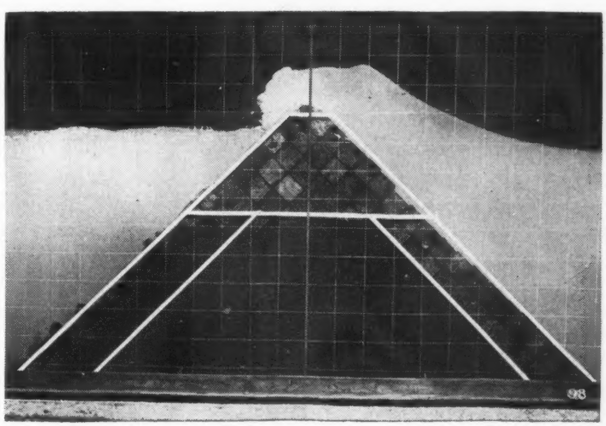
when it is necessary to observe internal flow characteristics in such features as outlet tunnels.

Particularly difficult and intricate are investigations of cavitation characteristics (that is, formation of vacuum caused by water flowing around some piece of equipment) of baffle piers in high-velocity flow. Atmospheric pressure surrounding the model must be reduced from the corresponding prototype pressure in accordance with the appropriate model scale ratio. Such studies are made in a variable-pressure water tunnel, in which pressure can be adjusted by a vacuum pump. Observations of the cavitation are made through plate glass windows.

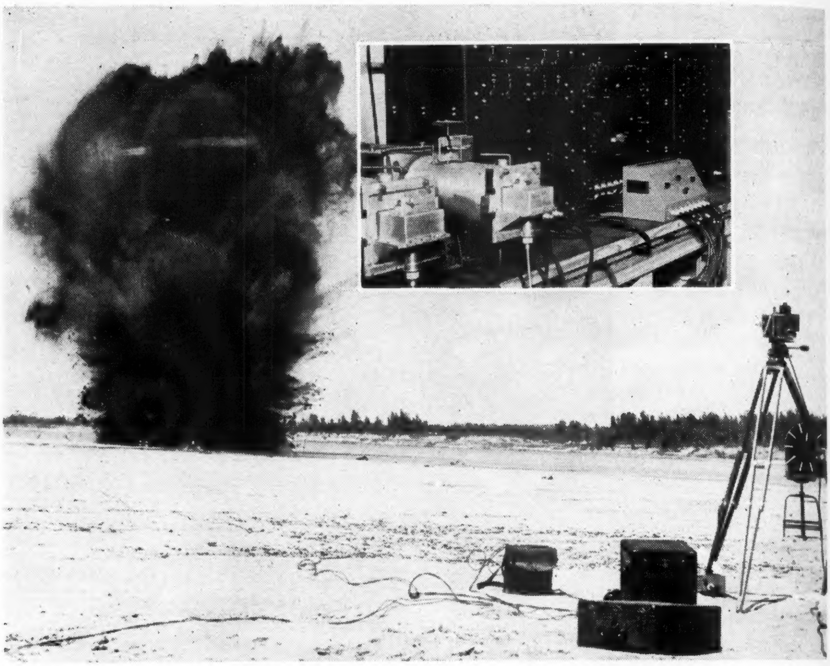
WAVE-ACTION PROBLEMS

STUDIES in wave-action problems are usually concerned with two things—first, design of the harbor itself to determine best locations and dimensions of wave-control structures; and second, designs of breakwaters, wave absorbers and other structures to withstand forces of wave action.

Though obviously most frequently utilized in connection with regular harbors, many wave-action studies at the Waterways Experiment Station are originated directly as a result of military need. One



The camera records a "30-foot wave" breaking against a cross-section model breakwater.



Study of military explosions is made with small scale detonations under and above water. Electronic equipment (inset) measures the effects.

such was a model study of the Naval Operating Base at Terminal Island, California, considering the problem of alignment of a breakwater needed during World War II to protect Navy vessels docked for repair. Another was used in development and design of portable triangular and cellular caisson breakwaters to protect landing craft during initial phases of the Normandy invasion.

Breakwater-stability tests often are conducted in glass-walled wave tanks to demonstrate the ability of various type structures to withstand the force of wave action. In miniature, the models withstand waves simulating "30-foot crests."

MILITARY EXPLOSIONS

SINCE 1951 the Hydraulics Laboratory has been conducting research studies of the effects of military explosions, primarily to evaluate the physical laws governing them. Specific purpose of the research is to develop empirical formulas which can be used to predict with usable accuracy the effects of nuclear explosions in various media.

Because coastal cities and vital harbor areas would be logical targets, scale models of many types and sizes are used to evaluate explosion effects in situations typical of those that would actually exist.

Studies are being made in two general categories—underwater and underground explosions. Primary effects measured in such tests include air, water, and ground shock; crater and crater-lip forma-

tions; water-surface waves; and plume and base-surge formation. Where no water layer is present, measurements are made of cratering, earth plume formation, velocity of initial ground rise, seismic velocity, air-blast pressure and other phenomena.

This research is carried on at an isolated explosives test site near Big Black River about 10 miles from the Experiment Station at Vicksburg. Here electronic recording equipment measures magnitudes and velocities of shock waves in air, water and ground.

It is obvious that by making all of these tests in miniature, utilizing models of harbors and other installations, data can be obtained that would otherwise be impossible to compile. When this is correlated with the limited data available from actual full-scale tests of nuclear weapons of various sizes, reasonable predictions may be made of the effects of explosions on shallow or deep water harbors, as well as on surface and underground installations.

HYDRAULICS DESIGN

IN THIS area Engineer scientists are able to check on the efficiency of models and research—for this is a continuous project of collecting, integrating, correlating and analyzing hydraulic performance from both models and the finished full-scale product such as dams, spillways, tunnels, gates, and the like.

As a result engineers throughout the country are provided with technical information necessary to design hydraulic structures so that they will be both more efficient and less costly.

Test observations from model studies, from university laboratory research and from structures actually in operation are compared and correlated to develop formulas, tables and graphs for use by design engineers. Published data are distributed to Division and District offices of the Corps of Engineers and other interested agencies.

In this way checks are provided on the accuracy of hydraulic model predictions as a means of furthering the science of model work. In addition this makes possible standardized and improved design techniques and procedures throughout the Corps of Engineers field offices.

RESULTS of the work at the Hydraulics Laboratory are felt by the entire country in many ways. The economy of the Nation is benefited by improved methods of flood control, conservation of waterpower, better and safer harbors which produce economic gains for large interior areas, more efficient hydraulic structures at lower costs, and in scores of other effects.

Militarily, benefits accrue not only to the Army Corps of Engineers but to the other services as well. Since establishment of the Hydraulics Laboratory in 1929, the art of experimental hydraulic work has developed from the rather crude pioneer model to the scientific method of today. The future should hold still greater advances.

Army Quartermaster technologists are doing their share toward

EASING THE S

William R. Lewis

FROM THE earliest days of warfare, the question of how much the fighting man should carry on his back has been hotly argued. All the debaters agreed then, and still agree, that this load should be as light as possible, with the soldier himself agreeing most heartily of all.

Through the centuries, various poundage figures have been proposed in an attempt to give meaning to the term "as light as possible," but in many instances the figure eventually translated into totals "ridiculously, if not tragically heavy."

During the many beachhead landings of World War II, the necessity for reducing the combat soldier's load was widely recognized, but little progress was made in actual weight reduction. In fact,

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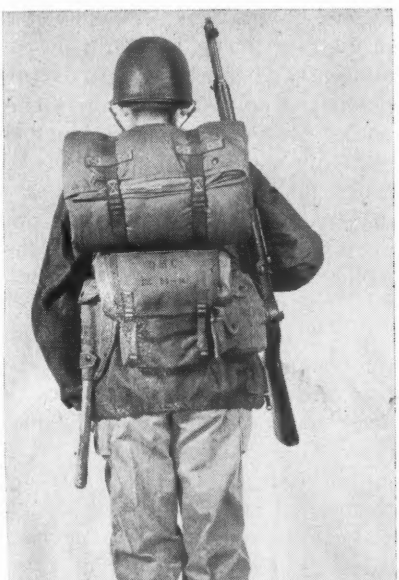
THE SOLDIER'S LOAD

with the additional requirements for protecting the soldier under extreme environmental conditions, and with the need for operating at greater distances from bases, there was even a tendency toward increasing the weight.

With war's end it was agreed that future progress in this field should be based on studies of the proper location of the pack and the tolerable weight and maximum load which the soldier should be expected to carry.



Since then, studies conducted by the Army have incorporated lessons learned from past experience, particularly in World War II. Using all available data, the Army Quartermaster Research and Development Command at Natick, Massachusetts, has been given the responsibility of producing an effective load-carrying system based on weight recommendations of Continental Army Command.

AS EARLY as 1950 CONARC's predecessor, Army Field Forces, had recommended that forty-five pounds be adopted as the optimum combat load to be carried by sol-

diers whose battle functions normally require movement on foot, and that fifty-five pounds be specified when march conditions prevail.

This outside figure of fifty-five pounds is, in effect, divided into three "loads," or segments of the total weight—the 20-pound "existence load," 25-pound "battle load," and 10-pound "full field load."

Each of these "loads" had to be studied separately and in the aggregate by Quartermaster technologists before a suitable carrying system could be developed.

The 20-pound existence load consists of those "survival" items which are essential to protect or maintain the individual combat soldier. These include the "C" ration; water (canteen, canteen cup and canteen cover); medical items (First-Aid-Packet with case, water purification tablets, salt tablets); toilet articles; towel; an extra pair of socks; helmet; pistol belt, suspenders and combat pack; two universal ammunition pouches; combination entrenching tool with carrier; bayonet or bayonet knife with scabbard; and pistol or carbine and ammunition. (The rifle is normally considered a component of the battle load.)

INCLUDED in the 25-pound battle load are such items as weapons (rifle or crew served) and their ammunition, unit equipment, and carrying equipment, all of which vary with duty assignment and hence are not identical for each soldier. In the main, they are the individual soldier's contribution to his fighting unit.

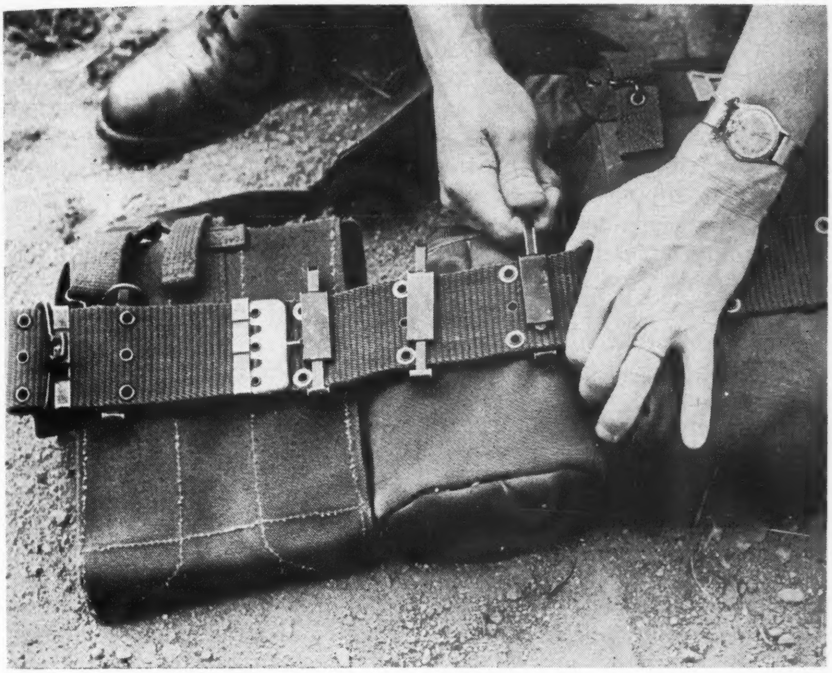
Items in this category include compass with case; rifle; grenade launcher; two hand grenades; universal carrying strap; rifle grenade; 96 rounds of rifle ammunition; and 40 rounds of BAR ammunition. The items enumerated would be the typical requirement of an assistant rifle squad leader.

The final ten pounds of the overall fifty-five consists of certain additional existence items which may be required for increased environmental protection or comfort when the soldier is on the march to or from combat, or otherwise in the field but not actually fighting. Typical items are sleeping bag and carrier, extra clothing, and personal items.

In 1951, following an extensive re-examination of all equipment then being stocked and issued for the purpose of carrying the individual soldier's load, Army Field Forces Board No. 3 outlined the problem in terms of two main coordinated efforts—(1) cutting down the soldier's load by eliminating every nonessential item and reducing the weight of the essentials; and (2) improving the means of carrying the load. Highest priority was assigned to reducing the weight of the soldier's equipment.

AS A first step in its attack on the weight carrying problem, scientists of the Quartermaster Research and Development Command analyzed all available literature relating to combat and load carrying equipment, as well as the design and development of various load carrying systems, including those of foreign armies.

Based on the results of these studies, and guided by current concepts of effective combat and marching loads in various tactical situations as set forth by Conti-



New type clips are used to fasten articles to the pistol belt, as shown in this close-up view.

nental Army Command, the Individual Load Carrying System, EX 54–10, was developed and is currently undergoing field tests.

The new system eliminates the maze of straps and buckles used on standard equipment and makes adjustment, attachment, and detachment easier and quicker. At the same time it increases flexibility in methods of carrying and in the bulk and weight that can be carried. In recent studies and field tests, soldiers have indicated that they greatly preferred the proposed items to the standard.

THE TWO basic components of the individual load carrying system are a specially designed belt and shoulder-padded suspenders.

Most of the components of the system are attached to the Belt, Pistol, EX 54–14. This item is fabricated from olive drab shade 7, water-repellent and mildew resistant, 2¼-inch-wide cotton webbing. Three rows of eyelets are provided in the belt. The top row is used for the attachment of the hooks of the suspender straps, the middle row to adjust the length, and the bottom row for attachment of certain standard items of equipment.

The belt is supplied in two sizes —regular, adjustable in length from 27 inches to a maximum of 44 inches; and large, from 33 inches to a maximum of 56½ inches.

The Suspenders, EX 54–14, are designed to support the weight of the pistol belt, other components of the individual load carrying system, and a sleeping bag. Of H-type de-

sign, they pass over the shoulders and drop straight down in back. To prevent them from slipping off the shoulders, they are joined together in the back by a 2¾-inch-wide web cross strap. The suspenders are supplied in two sizes —regular, designed to fit two thirds of the Army population; and long, to fit the other third.

THE eight attachable items are the combat pack, two ammunition pouches, canteen cover, combination entrenching tool carrier, First-Aid-Packet or Lensatic compass case, sleeping bag carrier, and a sleeping bag of the Comforter, Mountain or Arctic type.

Special fasteners increase speed and ease of detachment. The sleeping bag carrier straps, for example, are secured to the front of the suspenders by snap fasteners so the bag can be released and dropped instantly. The ammunition pouch is held closed by a leather strap with a keyhole shaped slot engaging a metal button set in the front.

In every aspect of design of the individual load carrying system, efforts have been made to provide for flexibility in carrying the various loads which must be carried by an infantryman of a forward battalion. His is the most difficult load-carrying problem of all soldiers. He must be prepared for prolonged movement on foot with only incidental reliance on unit transportation. It is he who must carry the indispensable equipment for close combat and survival into enemy territory.

To speed his forward drive, the Army Quartermaster Corps is continually seeking ways to lighten the combat soldier's load and make him even more mobile under all conceivable battle conditions. The proposed Individual Load Carrying System, EX 54–10, now undergoing tests, is an important contribution in this direction.

CONARC Boards

A NEW development and test agency —known as CONARC Board Number 6—has been established at Camp Rucker, Alabama, home of the Army Aviation School, by Headquarters, Continental Army Command. This brings to six the number of CONARC Boards engaged in specific development and test fields.

Board Number 1, concerned primarily with artillery equipment, is located at The Artillery Center, Fort Sill, Oklahoma, and works in close proximity with The Artillery School.

Board Number 2, concentrating in Armor equipment, is located at The Armored Center, Fort Knox, Kentucky, home of The Armored School.

Board Number 3, dealing with Infantry equipment, is at The Infantry Center, Fort Benning, Georgia.

Board Number 4, engaged in testing Antiaircraft Artillery and Guided Missile equipment, is at Fort Bliss, Texas, site of the AAA and Guided Missile Branch of The Artillery School.

Board Number 5, concerned with communications, electronics and Airborne equipment, is at Fort Bragg, home of XVIII Airborne Corps and the 82d Airborne Division.

The six development and test agencies are under the command of General John E. Dahlquist, Commanding General, Continental Army Command.

Those Northern Lights may be weirdly beautiful but they also cause interference which plagues researchers seeking

Better Military Radio Reception

Alan S. Gross

TO THE MOTORIST whose car radio sputters when he drives alongside a high voltage line, or the listener at home whose reception fades for no apparent reason, the entire matter is merely one of inconvenience. But the faltering or failure of military radio at a critical moment may well prove disastrous.

In a continuing effort to assure that military communications will work under many different conditions—varying from short range to world-wide and including all types of climate and weather—military radio equipment has been greatly improved year after year. Smaller components, more rugged construction, better power sources, improved tubes and antennas—all have led to better, lighter, more useful equipment.

Making possible these mechanical improvements and new inventions is a continual program of research in the very fundamentals of what makes a radio set work, whether it be the instrument in the motorist's car or one in a military tank or airplane.

The program involves the study of the means, methods and idiosyncracies of the propagation of electromagnetic waves. Phenomena associated with the propagation of radio waves are intimately connected with the frequency of the radiation. Affecting this entire area are factors ranging from atmospheric conditions to sunspots—some of which can be controlled or surmounted and some of which are still surrounded with considerable mystery.

IMPORTANT as is this entire field of investigation, it is but little publicized and in fact is seldom recognized by many of the very people who stand to benefit most from it. As is so often the case with military research, these benefits extend far beyond the limits of the services. Every advance that is made in understanding and solving the fundamental problems of electromagnetic wave propagation is of value to civilian radio and television.

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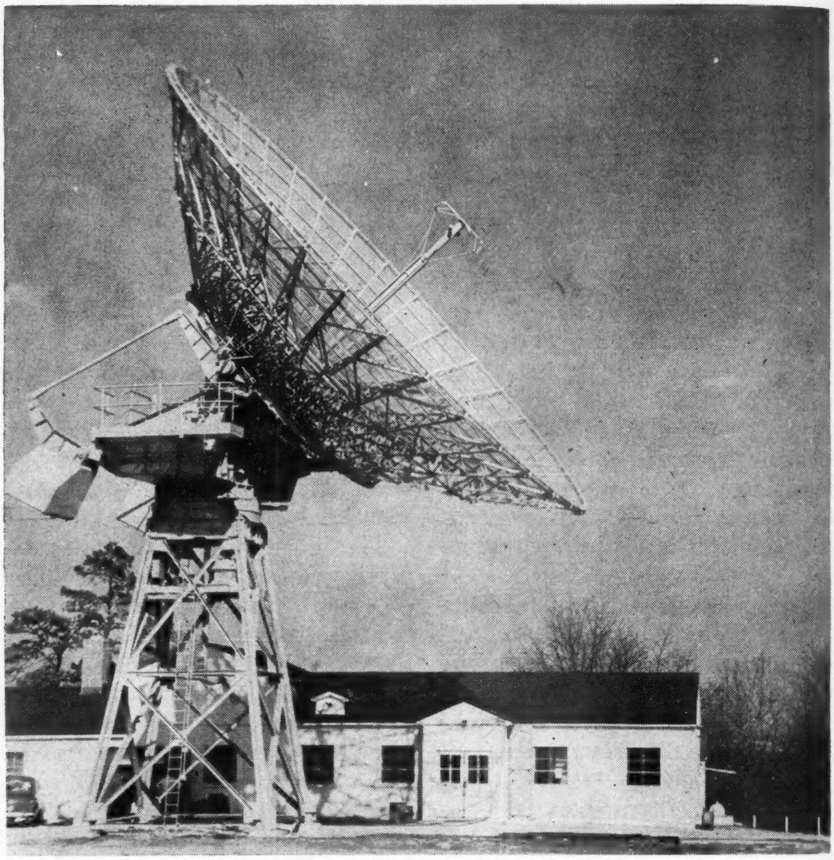

This experimental parabolic antenna reflector is one of the special devices being used in studies of very long range radio propagation.

All branches of the Defense Department, the Federal Communications Commission, the National Bureau of Standards and other Government agencies and many universities and private industrial organizations carry on programs aimed at solving the problems in this sphere.

As a specific example of military research and cooperation among the various interested organizations, the Signal Corps Engineering Laboratories at Fort Monmouth, New Jersey recently standardized the Propagation Frequency Evaluation Set AN/CPQ–7, based on a Bureau of Standards Ionosphere Recorder design. Thus a basic piece of equipment is available to take recordings of the height of the various ionospheric layers and the frequencies reflected therefrom, to broaden our knowledge of radio propagation principles.

Even the casual radio listener has heard or read about the various wave lengths and realizes that they have their own characteristics—some being valuable for long dis-

tance communications while others are limited in range.

NEARLY everybody today also has heard of the troposphere and the region above it, the ionosphere, and knows that the layers in the ionosphere have some effect on radio waves.

Those engaged in the technical aspects of radio in the Armed Forces of course learn a good deal about all of this. But for the many commanders and other personnel who must use radio communications or plan for their use, yet cannot make an exhaustive study of the matter, some knowledge of the classification of radio waves, some explanation of how the ionosphere controls propagation, and some background on other phenomena will be of considerable value.

THE ionosphere may be thought of as an ionized region or a conducting shell for radio waves, extending 30 to 300 miles above the earth's surface. Just below it, ranging from the earth upward to about the 30 mile mark, is the troposphere. To explain the theory behind the function of the ionosphere would require an extended technical treatise. Suffice it to say that the major cause of ionization is the electromagnetic radiation from the sun. In addition, meteors, particle radiation from the sun, and cosmic rays have varying effects.

Within the ionosphere itself are four generally recognized "layers" which produce varying effects on radio waves. In order of their increasing height and density, they are known as the D, E, F1, and F2 layers. Heights of all layers vary somewhat with the season, lower heights occurring when the sun is overhead. There also are marked differences in effect from daytime to night.

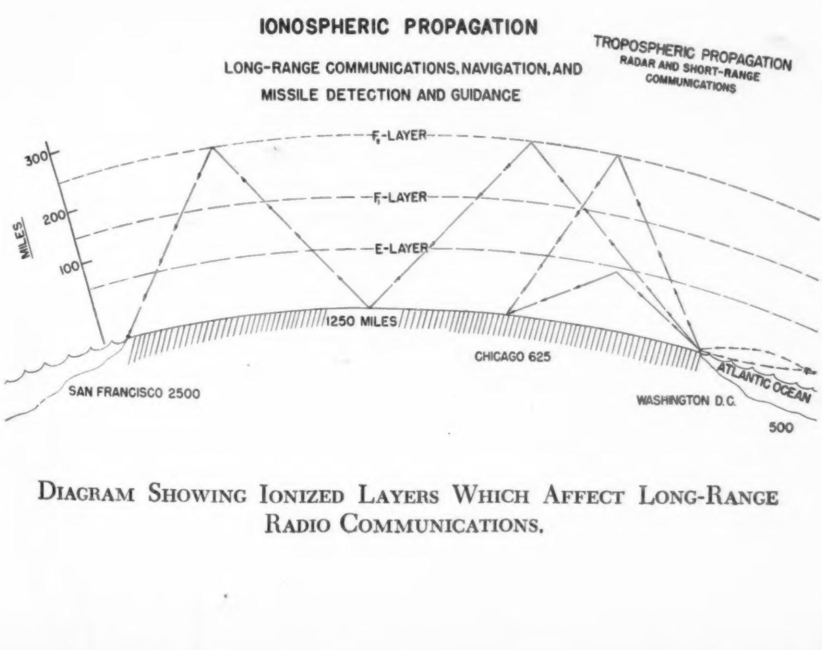

DIAGRAM SHOWING IONIZED LAYERS WHICH AFFECT LONG-RANGE RADIO COMMUNICATIONS.

The D and E layers, for instance, occur only during daylight hours. The D layer ranges from about 30 to 55 miles while the E layer extends above that to about 90 miles. Above this is the F layer with ionization existing at all hours, usually with two well-defined regions during the daytime which merge to make one at night.

In the daytime the lower layer is known as F1, and ranges from about 90 to 155 miles; the upper is designated as F2. The latter is the most highly ionized and most useful for long-distance communication. Heights vary with the seasons, and degree of ionization varies from day to day in comparison with the other layers. The F2 layer appears to be affected greatly by heat since it is thicker in summer.

WITH this as a brief and basic background, then, the advantages and limitations of the various wave bands may be better understood. The following table which lists a general classification of these radio waves is obviously not to be considered a rigid outline. As used here, the term "attenuation" means a weakening of the wave which occurs as it travels away from the transmitting antenna. "Kc" stands for kilocycles, "mc" for megacycles.

	Frequency	*Wavelength (meters)*	*Characteristics*	*Use*
LONG WAVES	Below 100 kc	Above 3000	Wave travels over earth's surface between ground and lower edge of ionosphere. Low attenuation.	Medium and long-distance communication. Sferics. Direction-Finding.
MEDIUM WAVES	100 kc to 3 mc	3000 to 100	Wave travels over earth's surface during day, some energy reflected from ionosphere at night. High attenuation during day, low attenuation at night.	Broadcasts, Marine and Aircraft Communication, and Direction-Finding.
SHORT WAVES	3 to 30 mc	100 to 10	Wave reflected by ionosphere. Reflection conditions vary greatly with time of day and season. Small attenuation if conditions are favorable.	Long-distance broadcasts, long-distance point-to-point communication.
ULTRA SHORT	Above 30 mc	Below 10	Wave travels over surface of earth only and for relatively short distance.	Television, short distance aircraft guidance systems, etc.

WITH this as basic background, it is possible to begin to view some of the problems arising in military communications. For frequencies below 100 kc, equipment is cumbersome and antennas large, so that stations usually must be of fixed location, non-mobile types. Few frequency assignments can be made on a non-interference basis, so the range is limited to special stations for particular problems.

In the area of the medium waves, the D layer absorbs the sky-waves, so that transmission is limited to ground-wave propagation. This means high attenuation limits the range to about 200 miles in the daytime. But once the sun sets, small stations transmit to greater distances via the ionosphere, since the D layer disappears. However, the interference problem is increased over that existing during the day.

The 3- to 30-megacycle band is most used for military communications. Long distance skywave transmission generally is most effective at frequencies from 3 to 12 mc during the night, and from 6 to 25 mc during the day. Further, the entire band may be used for ground-wave transmission for relatively short distances over land, and for moderate distances over water.

Ultra short waves—those above 30 mc—are used for short distance communication. Since these frequencies normally are not reflected by the ionosphere but travel more or less in straight lines, the range does not greatly exceed line-of-sight distance. This propagation, therefore, is differentiated from ionospheric propagation and is designated tropospheric. At the upper level, frequencies in this range are useful for radar and secure communication networks.

ONE might assume that it would be fairly easy to select a frequency which would enable sending information to a desired point depending on the time of day, season, and distance. However, the problem is far from simple because of many other factors.

One of these is solar activity. Besides day-to-day and seasonal variations, changes in the layers occur corresponding to a long-term variation in the sun's activity. Such variation has long been known to occur. Records go back as far as 1610 when Galileo compiled data on this phenomenon.

Sunspots themselves are only one evidence of solar activity but are the most convenient solar phenomenon to observe. A study has established that there is a mean period of slightly more than eleven years during which the degree of sunspot activity fluctuates from minimum to maximum and back once again. The period is not a smooth one. All that can be said is that the *average* activity can be plotted as a rough cycle of about eleven years.

VERY briefly, two general phenomena, both apparently tied to sunspots, affect radio broadcasting adversely. These are eruptive disturbances in the sun causing sudden ionosphere disturbance, and longer lasting ionosphere storms.

The first throw off huge quantities of gaseous matter and a large amount of energy in the form of radiation of various wavelengths which travel at about the speed of

light. Because they include visible light, they may be seen on earth as bright flares. The second phenomenon throws off particles which travel at about 900 miles an hour, bombard the earth, cause magnetic disturbances and often produce the brilliant polar aurorae known as the Northern or Southern Lights.

Oddly enough, there is another abnormal condition known as "sporadic E" which actually tends to improve reception. This phenomenon is believed due to formation within the E layer of a region that acts like a highly ionized layer. Most frequently encountered late in the day during summer, it appears and disappears in highly erratic manner; and while it does sharpen reception, it often causes signals to be heard in undesired locations.

When eruptions of sufficient intensity occur on the side of the sun facing the earth, they produce effects only in the daylight portion of the earth. The eruptions are very short but the effects often are felt long after they have died down. Waves travel through the ionosphere until they are absorbed by the ozone layer about 38 miles above the earth.

THE effect of these waves on short-wave reception is dramatically impressive. Everything appears to "go dead", even the background noises. Only the sky-waves in the sunlit hemisphere are affected. Signals usually fade away entirely within a minute or two and then return slowly over a period up to two hours. The higher frequencies recover first.

In the case of ionosphere storms, the effect is not so intense but the storms usually are of greater duration (up to several days) than the sudden ionosphere disturbances. Short-wave signals drop to a low level and often disappear entirely. There is a great increase in signal fading, with high frequencies most affected. Unlike the sudden ionosphere disturbances, the storms affect the dark hemisphere as well as the sunlit portion of the earth's surface.

The wave radiation which causes the ionosphere storms appears to assume the form of a cone with the eruption at its apex. Unless it is emitted from a position on the sun which is aimed more or less directly at the earth, it will miss the planet.

On the other hand, there seems to be some relation between ionosphere storms and bright solar eruptions near the central meridian of the sun (and only in this region) since frequently such eruptions are followed in 25 to 30 hours by ionosphere storms.

SUCH a correlation is not perfect, for storms may occur when no eruption has been seen and, in fact, when there has been no spot near the central meridian although there may have been spots on other parts of the sun. There also are indications that these storms recur at intervals of about 27 days, roughly corresponding to the average rotation period of the sun.

When the charged particles approach the earth's atmosphere, they are affected by the earth's magnetic field; they move toward the poles and so their effects are most intense in the polar regions. Violent fluctuations known as magnetic storms disturb the earth's magnetic field.

INTENSE variations in the geomagnetic field often cause the phenomenon of the aurorae. Because of the greater intensity of magnetic storms in the polar regions, transmission paths often are severely affected by the aurorae. The colored lights are ascribed to emission of visible rays by molecules of atmospheric gas when subjected to bombardment by the solar particles.

Not only do all of these factors have an effect on short-wave broadcasting, but in the field of ultrashort waves which travel through the lower atmosphere, such obstacles as terrain, weather and atmospheric composition, rain, snow and hail particles may have an adverse effect. Sometimes waves traveling horizontally or at low angles of elevation become trapped by refracting layers of air and are bent back toward the earth just as though in a metallic waveguide. Thus they may follow the curvature of the earth far beyond the optical horizon of the transmitter.

FROM all this it may be seen that many difficulties exist in planning a world-wide net of communications. Lesser, though still difficult, problems are encountered in short range transmissions.

Where military requirements may call for secure-circuit transmission, interfering phenomena may cause the sending of signals into undesirable zones.

Present world conditions point to the importance of the Arctic, yet the least reliable communications exist in polar areas.

CURRENTLY the Signal Corps Engineering Laboratories are directing a series of experiments in Alaska, utilizing the facilities of the University of Alaska and an Arctic Ionosphere Research Detachment.

These studies are investigating transmission and reception paths, both parallel and at right angles to the auroral zone. Tests are undertaken on three different frequencies. Correlation of the data and other measurements, it is hoped, will shed more light on problems of radio propagation in the Arctic.

The Signal Corps Engineering Laboratories also are conducting ionospheric and tropospheric research in an effort to obtain still more answers to the various problems of the ionospheric layers. Work in this field will be with transmitters at 151.11 and 413.25 mc.

Working under a government research contract, scientists at Cornell University have been conducting an investigation of the characteristics of the ionosphere at high, medium, and low radio frequencies during both absence and presence of auroral disturbances.

These are but a few of the many and varied projects now going on. In every area, research programs continue to anticipate problems which may arise. They also will lay groundwork for new and better radio and radar design. The solutions to radio propagation problems will help provide the reliable communications so necessary to military success.

The Microwave Radar Beacon in

Peter Mares

AT THE ARMY'S guided missile test ranges, radar plays an all-important role in the instrumentation of guided missiles, projectiles and aircraft. Ballistic data, including behavior during flight, velocity, continuous trajectory and positional information, are supplied by radar systems. Once the link has been established between the missile and a tracking radar, auxiliary functions such as missile guidance and the telemetering of missile data are possible.

In the conventional radar system, the transmission of a powerful ground-based pulsed transmitter is directed at an airborne target by means of a highly directional antenna. A sensitive receiver, integral with the radar system and tuned to the radio frequency of this transmission, picks up a portion of the transmitter radiation and the pulse energy reflected by the target.

Though the radar beam is quite sharp, extraneous reflected energy from surrounding topography enters the receiving system and presents an interference problem known as "ground clutter" which is common to all radars to a greater or lesser degree. This effect is particularly troublesome when the radar is directed at low-elevation angle targets, and may be further aggravated by conditions at certain radar installation sites.

The effective range of a given radar system is dependent upon such factors as the power output of the transmitter, sensitivity of the receiver, area of the antenna and the reflecting area of the target. Radar transmission, being a form of electromagnetic radiation, behaves in accordance with the well-known phenomenon of the inverse square law of attenuation with distance through space. Accordingly, there is a practical limitation to the extent that the power output, sensitivity and antenna size of a radar system may be increased to achieve a given range with a particular target.

USE OF a radar beacon—a microwave receiving and transmitting instrument—in the radar system, however, tends to obviate the ground-clutter problem by permitting a substantial frequency separation between the radar transmitter and receiver. Operating range is extended by increasing the signal

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...acon Pinpoints Missiles In Flight

Peter Maresca

power returned to the radar receiver. Since the beacon acts as a point source of radiation, targets so equipped are tracked with greater accuracy because the tracking-radar beam no longer tends to scan the entire target area, seeking the center of gravity of the reflected signals.

Radar tracking beacons are triggered devices; that is, the beacon does not emit a radiation until interrogated by a radar signal, usually coded, and within the receiving frequency band of the beacon receiver. Since relatively feeble signals—as little as three-billionths of a watt—are sufficient to trigger the beacon to pulse-power outputs from 25 to 2000 watts, the action of the beacon may be likened to that of a radar relay station reinforcing the original radar signal by a tremendous factor. A given beacon, once triggered, replies with a constant power output, dictated by its inherent design, and independent of the power level of the triggering radar signal.

The power supply, which provides the beacon with the necessary operating potentials, may be completely battery-operated or may use some form of power converter such as a vibrator, dynamoter or transistor oscillator, in which a battery is used as the prime power source. The exact design of the power supply depends upon the operating life required during beacon flight and the available prime power source.

The Signal Corps has developed, and is continuing the development of a line of microwave radar beacons which vary in weight from one to several pounds and which provide beacon operating life from 15 minutes to many hours, limited only by the prime power source. These beacons, by the very nature of their application, must be of rugged design and capable of withstanding the large amounts of shock and vibration encountered in guided missiles and projectiles.

Radar beacons of this type are being successfully used at the White Sands Proving Grounds in experimental Army missiles. These slender instruments are the sensitive "brains" of the guided missile aloft—the indispensable link in tracking and reporting on the missile's performance.

Army Map Service mass produces plastic relief maps to provide

3-D for the Army

Colonel Julian D. Abell

WHILE 3-D has gained increasing popularity throughout the nation, reaching all ages through the medium of entertainment from comic books to moving pictures, it is a little realized fact that the Army also has pioneered its own brand of 3-D in a more concrete form—the three-dimensional plastic relief map.

Military leaders have long known that the symbolization of mountains and valleys by contour lines on standard flat topographic maps is difficult to convey, especially in conducting strategic and tactical briefings for units planning operations over unfamiliar territory. Terrain models have proved to be a valuable visual aid in planning the course of attack, but these products—constructed from plaster, papier mache, or sponge rubber—are heavy, bulky, and costly to produce. Consequently, their use has been limited to the higher echelons.

In its search for a product that could be rapidly and economically processed and distributed to men in the field, the Army Map Service came up with an improved method of transforming a conventional flat contour map into a three-dimensional product.

In this method the information appearing on the conventional map is printed on sheets of thermo-

COLONEL JULIAN D. ABELL, Corps of Engineers, is Commanding Officer, Army Map Service.

plastic material which are then molded, by the application of heat and vacuum, over a terrain model precisely constructed to correspond to topographic detail.

FIRST step in constructing such a model is to transform the contours of the topographic map into a three-dimensional land form base with each contour lying in its true position. This is rapidly and accurately accomplished on a pantographic cutting machine of German design. (*Figure 1*)

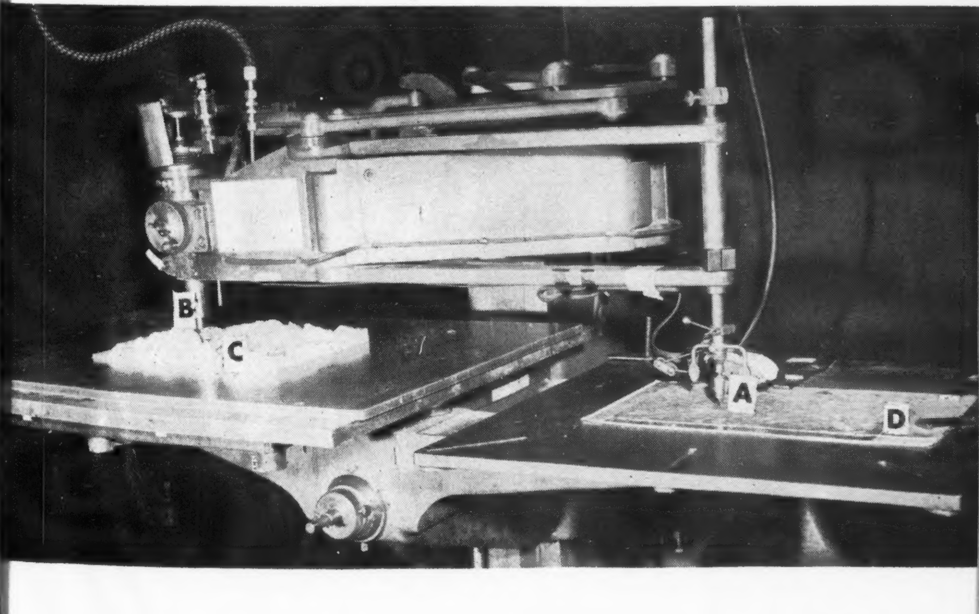
A zinc etching of the contours is prepared and clamped to the right hand table of the pantograph. On the left hand table a block of laminated acetate sheets is oriented to the contour plate, the thickness of each sheet of the block being equal to one contour interval of the map. As the operator guides the tracing needle along the etched contour line representing the highest elevation, the blade, adjusted to cut through one layer, cuts the same outline from the block. The excess material is stripped off, leaving the contour outline in a raised or stepped form.

This procedure is continued for each contour elevation until a complete landform base appears in stepped form. From this acetate base a negative stepped mold is cast in low-expansion plaster. From the negative, a positive stepped mold is cast and then coated with a yellow ocher solution.

Development of the landforms into a replica of the earth's surface is accomplished by carving away the step edges, leaving a fine line of ocher at the base of each step. These lines, identical to the contour lines from which the model was cut,

FIGURE 1

A pantographic machine cuts the three-dimensional landform base. Note tracing needle (A) and cutting blade (B) which has cut the stepped base (C), using etched contour plate (D) as a guide.



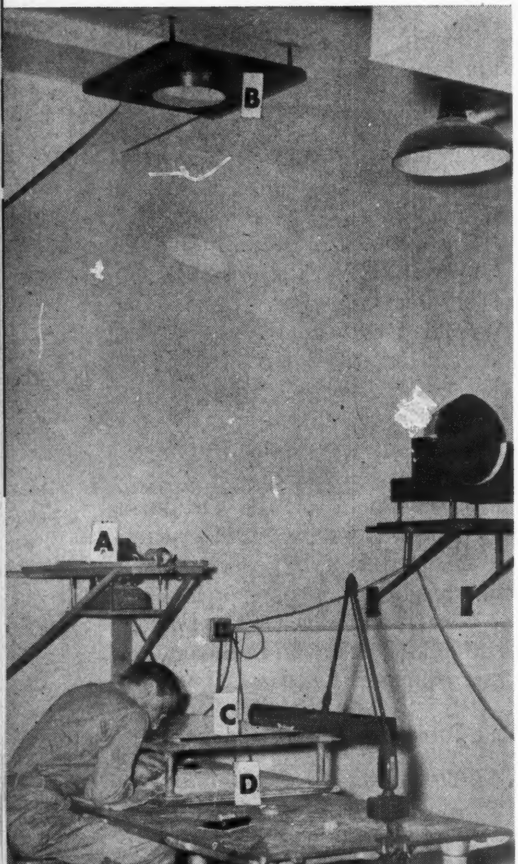


FIGURE 2

Accuracy of the model is checked on this optical device. The light source coming from (A) is reflected in parabolic mirror (B) to contour glass plate (C). Model is at (D).

are retained as editing guides.

EDITING for horizontal accuracy is performed at each phase of the model's construction on a special optical device. (*Figure 2*) A glass plate, bearing the flat map contours and drainage, is placed six to eight inches above the model. Light rays emanating from the projector strike a parabolic mirror which transmits these rays in parallel beams through the glass plate. This permits the shadows of the contour lines to be cast perpendicularly to the surface of the model, regardless of the relief. If the model is accurate, the control lines retained in carving coincide with the projected lines. If they do not, the model is corrected.

While the original model is being constructed, the plastic maps are printed and are ready to be formed over a production positive mold. The latter is derived from the original carved model by first casting a negative, from which the production positive is made.

PRIOR to the actual forming operation, valleys and low areas in the production positive are perforated with minute holes to permit evacuation of air from beneath the sheet during forming. The positive mold is then mounted within a vacuum box, which in turn is mounted on the forming machine. (*Figure 3*)

Next, the flat plastic map is clamped into position over the mold and subjected to radiant heat for a brief interval, sufficient to soften the sheet. Full vacuum is then created beneath the sheet, instantaneously forming the softened plastic over the landforms of the

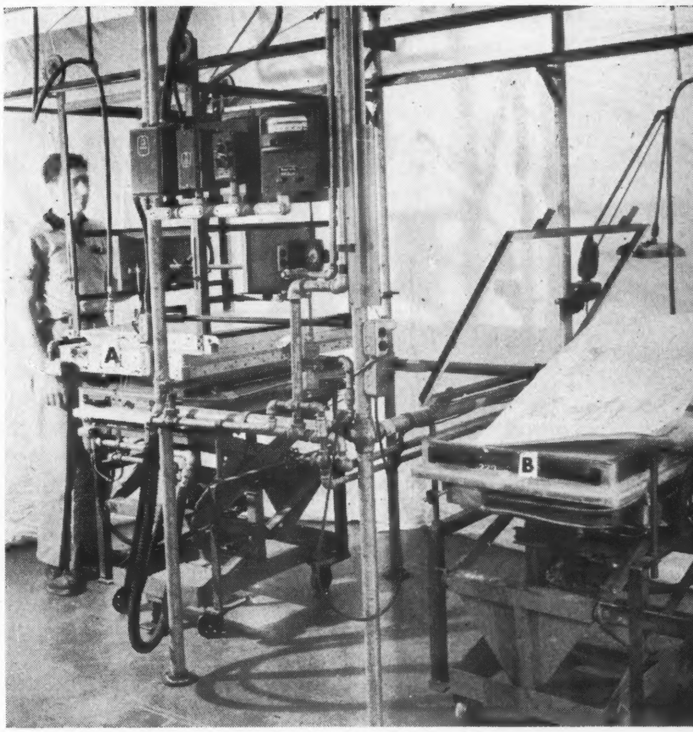


FIGURE 3

Plastic maps are produced on a dual vacuum forming machine. The radiant heater (A) is placed over vacuum box assembly while a completely formed map is removed from an opened assembly (B).

mold. After cooling, the completely formed map is removed, trimmed and shipped to the ultimate user.

In the plastic relief map the Army has a product which is not only identical to the paper map, but also portrays mountains, ridges, valleys, and other topographic information in three dimensional form. Even a person untrained in map reading can thus readily visualize and interpret the topography of an area and properly orient himself with his surroundings.

As a result of Army Map Service development efforts, terrain models once arduously prepared and limited in distribution can now be mass produced and widely disseminated to bring the Army ever closer to its objective of seizing and holding ground despite all obstacles.

ARMY INFORMATION DIGEST is distributed officially through channels to the company level. Individuals and units desiring to enter personal subscriptions ($1.75 per year to domestic or APO addresses; $2.25 to other addresses) may do so through the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

Hauling bigger loads on more compact bodies at less cost is the trend in

New Military Trucks

Lieutenant Colonel John H. Davis

SMALLER and lighter, yet larger—

More powerful and with greater mobility, yet much cheaper to operate—

These will be just a few of the attributes of the military wheeled vehicles of the future.

Although it sounds a bit complicated if not impossible, these goals are fast approaching attainment as Army Ordnance research and planning proceeds from drawing board to prototype production of a new family of military trucks.

Such changes are not being planned just for the sake of change. The present family of vehicles ranging from the Jeep to the recently standardized 10-ton type are good trucks, performing well in difficult tasks. Yet in nearly every instance they were conceived in war-dictated haste and built in a race against time; it was inevitable that weaknesses and defects in design would show up.

Currently it is planned not merely to strengthen the weaknesses and rectify design but to produce a family of trucks that will fit exact military needs, be more efficient, and at the same time save the taxpayer money.

Because the several existing truck sizes are not the result of caprice or chance, but rather of the dimensional requirements for various loads of a field army, future planning is based on producing a family of vehicles in about the same load ranges as at present.

THE family of standard Army vehicles in general use today consists of the following types:

The Jeep, actually a quarter-ton truck, is essentially a command reconnaissance vehicle, although it can and does mount certain weapons and further has some cargo carrying capacity.

The ¾-ton truck, basic weapon carrier and smallest cargo vehicle, is a transition type since it falls between the personnel transport of the jeep and the pure cargo carriers. Such a vehicle is naturally difficult to contrive to satisfy all users.

The 2½-ton truck, "workhorse of the Army", widely used during World War II and improved for Korea, forms the backbone of field army needs.

The 5-ton 6x6 truck is a genuine heavy hauler. Like the 2½-ton, it

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LIEUTENANT COLONEL JOHN H. DAVIS, Ordnance Corps, was Chief, Transport Vehicle Section, Tank-Automotive Branch, Research and Development Division, Office of the Chief of Ordnance.

comes in varied types—cargo, dump, truck tractor, van, wrecker, and others where stated requirements exist.

The new 10-ton 6x6 truck is the Army's heaviest cargo carrier. It is also intended for towing semitrailers of 25 or 30-ton load capacity. Present plans call for a cargo version to be manufactured for possible service as an Artillery prime mover.

In the case of these standard vehicles, normal testing has been carried out at the so-called "highway loads" which are much higher than the actual designation would indicate. Thus the Jeep can readily carry 1200 pounds; the 2½-ton, 10,000 pounds; and the 10-ton has a gross train weight of 104,000 pounds. Generally, these vehicles are designed to handle highway payloads under practically all conditions of operation. In fact when several hundred 2½-ton trucks were stopped at a check point in Korea, the average load was found to be no less than seven tons.

IMPROVEMENTS in design had been made and more were being planned when Korea burst into flame in 1950. At that time it appeared that the smouldering fuse of a third world war might have been ignited. Haste in procuring trucks was the order of the day.

It was quickly apparent that any vehicles that would be available in quantity would be those very close to the commercial designs then in production. Above all, the trucks had to be producible, using production lines and tooling already set up or quickly available. As an example, it was necessary to adapt a passenger car automatic transmission to a heavy military truck in order to avoid having to build and tool a transmission factory.

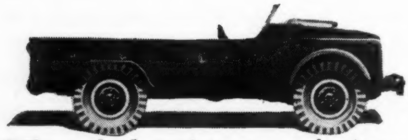
Volume output also was a vital consideration. If another world war was at hand, the need for trucks in tremendous quantities would make itself felt overnight.

Because of the redesigns that had been accomplished in 1950, the life cycle of existing vehicles is several times that of the World War II types, even when hauling greater payloads. But weaknesses and plain bad design did crop up, and other deficiencies of a relatively minor nature caused severe maintenance problems in the field before general corrections could be made.

IN considering trucks of the future, the mission of the organization to which they may be assigned must establish the base line. Since any general-purpose vehicle may be assigned to any organization in a field army or a communication zone, each must be capable of the maximum effort to which any may be subjected.

Stated another way, it is impossible to design and manufacture large varieties of trucks for special purposes. It often is said that only a small percentage of all trucks are called upon to travel cross-country or to operate under severe conditions. Yet no tactical or support commander can say exactly *which* truck may be required to make such an effort. Similarly our entire military establishment is a type of insurance that any possible mission can and will be accomplished.

Despite changes in both load and dimensional factors of TO/E materiel, and despite changes that appear imminent, design studies for



"The vehicles of tomorrow's Army are certain to be able to take a greater payload in smaller, lighter bodies . . ."

military vehicles are being completed that will enable building of trucks in about the same sizes as those of World War II.

ONE OF THE considerations in designing such vehicles is that they now must be capable of being airborne in some phase of operation. The exact phase, of course, depends on the placement of the vehicle and its load in the echelon being air landed or dropped.

Military vehicles will not only be used to haul men and materiel but will themselves be hauled by air. This is in line with the concept of greater air mobility for entire ground armies.

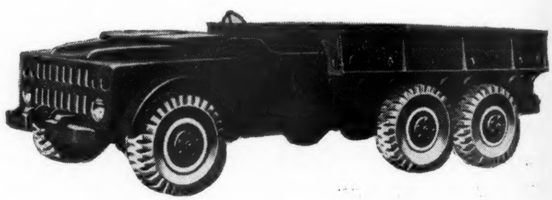
This aspect is perhaps the most stringent requirement that will affect sizes and weights. The entire problem also is tied up with airborne phases of operations and with aircraft design.

At present, the designer's goal must be to make certain that predictable capabilities of design provide the maximum cargo capacity for the minimum vehicle weight and size overall.

EVEN NOW it is possible to forsee some of the engineering developments and manufacturing improvements that will lead to better trucks. A discussion of such possibilities must of necessity be stated in general terms since the Army cannot plan for new annual models as do civilian producers.

A projection of the family of vehicles concept into the future points to several truck types, keynote of whose design will be producibility at moderate cost. They will be especially well suited to their military mission through a careful arrangement of essentially commercial components.

". . . the famous old 2½-ton 6x6 may attain the range of the 5-ton 8x8."



Such trucks will cover the weight ranges already in use, to provide a maximum of user flexibility. A larger number of vehicle chassis and body types will be provided, but due to interchangeability they will require fewer parts to support them.

THE VEHICLES of tomorrow's Army are certain to be able to take a greater pay load, in smaller, lighter bodies; they will have greater mobility and will be cheaper and easier to maintain. It is not difficult to foresee that the present ¼-ton utility truck may take on the capabilities of the ¾-ton 6x6

while the famous old 2½-ton 6x6 may attain the range of a 5-ton 8x8.

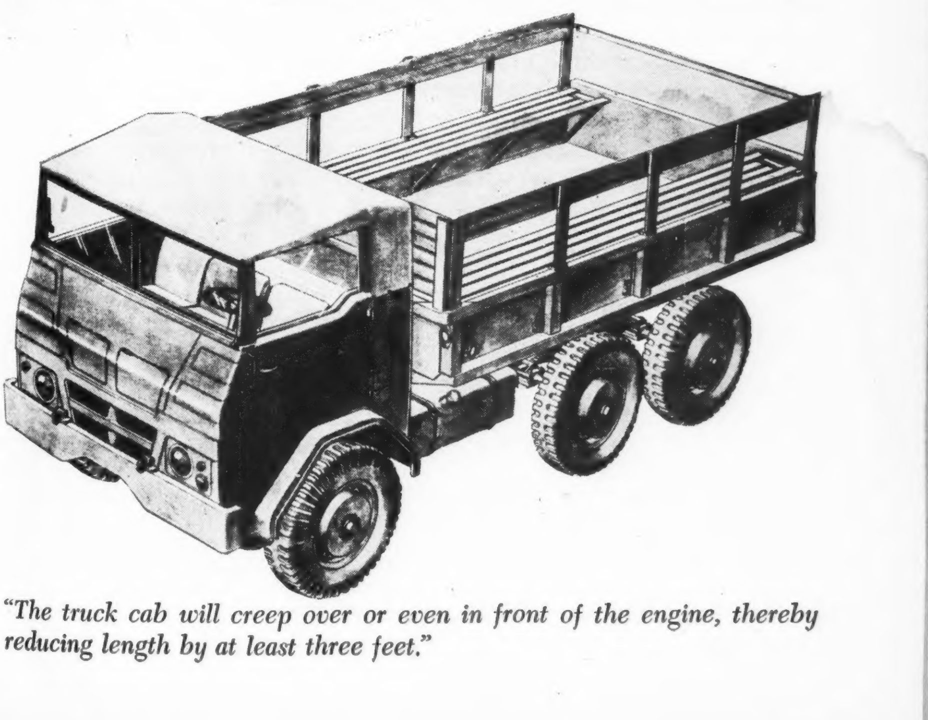
Trucks will be made smaller by providing better access and by reducing required access to a minimum. The truck cab will creep over or even in front of the engine, thereby reducing length by at least three feet. Body design will permit ample strength in the side members in narrower sections than now used.

Greater attention to design of winch, spare tire mounting, bumpers, tow hooks, and the like, will reduce dimensional requirements. In smaller vehicles the overall height will be reduced but in the larger cargo types (2½-ton and above) no change in height appears necessary.

Weight reduction may be gained by the use of lightweight material, lighter design or reduced requirements (either in payload or usage). All methods will be explored and exploited with a full awareness that there really is no easy road to weight reduction.

Lightweight materials and design are part and parcel of each other—it does not simply involve arbitrary substitution of a lighter metal for steel or cast iron. Sometimes redesign in existing metals may solve the problem, and at a far reduced cost.

Again, the problem of producibility is encountered. The automotive industry has not used lightweight materials to any great extent where stresses are critical. The industry must learn how to work with these materials and to produce them in quantity. However, if the design goal is hauling of loads similar to those now handled, weight reduction of about 20 percent should be possible without loss in durability or reliability.



"The truck cab will creep over or even in front of the engine, thereby reducing length by at least three feet."

REDUCTION in weight will be reflected directly in increased economy and also in mobility. At the same time, lighter and more efficient engines, with higher compression—as high as 9:1 or 10:1—also will lower operation costs. These engines probably will be of V8 design, using fuel injection rather than carburetion. A saving of up to 25 per cent in fuel costs should be possible.

What is more, these fuel injection engines will perform on gasoline, kerosene, diesel fuel or even liquefied petroleum gas. Performance on any of the fuels should be about the same.

A further advance in motivation power will result from development of turbines. Right now they offer no promise of fuel saving but it is expected that they will be developed to the point where they will at least equal and probably better conventional engines.

Improvements in transmission designs also will contribute to increased economy. As torque converter or fluid coupling transmissions become more efficient, actual economy in operation of heavier load trucks may be expected to result.

These new vehicles will have greater mobility to include air transportability. They will perform better under adverse terrain conditions, such as deep mud or sand, because of increased ground clearance, better weight distribution, higher ratio of horsepower to weight, torque biasing differentials, and new design tires. They will be easier to start, and will have greater capability for crossing shallow streams or obstacles.

Reliability of these vehicles of the future will be tremendously increased—even beyond that in commercial practice today. Aggressive maintenance engineering will increase durability of components and reduce the manpower, maintenance equipment and supplies required to keep them in serviceable condition. Thus fewer vehicles will do more work and provide the high mobility required by modern concepts of warfare—all this without excessively restricting manpower and supply elements.

Dual Purpose Truck

Designed primarily for petroleum pipeline construction, a dual purpose truck developed by the Corps of Engineers' Research and Development Laboratories will also do double duty as a cargo vehicle.

The new unit is built on a standard military 2½-ton truck, equipped with a rear or side mountable A-frame, a rear-of-cab mounted winch and rolling tailboard. The winch has a capacity of 20,000 pounds and by using the rolling tailboard a driver can load or unload skid-mounted equipment such as pumping units without assistance.

By adding cargo sides, troop seats, lazybacks, bows and paulin, the truck can be transformed within a few minutes for cargo or personnel. The World War II pipeline truck could not be so converted.

Food is the fuel for men who deliver the firepower, emphasizing the fact that

Nutrition Is Also the Commander's Business

AS LONG as armies have existed, a principal concern of commanders has been the provision of adequate food for their troops. Physical efficiency and morale depend to a great degree on the adequacy of the ration—its quantity and palatability. Equally important but not so readily apparent is its nutritional adequacy—the amount of essential nutrients required—which may vary widely with the degree of physical activity and age of troops, environmental temperature and other local factors.

Important studies and experiments in this area are being conducted by scientists of the Medical Nutrition Laboratory at Fitzsimons Army Hospital, Denver, Colorado. Their studies of diet and its effect upon the soldier's stamina and health have far reaching implications. For example—

Certain changes in body weight occur in young men inducted into the Army. Are these changes beneficial?

LIEUTENANT COLONEL CARL J. KOEHN, DR. THEODORE E. FRIEDMAN, PFC RUSSELL A. VAN DYKE, and PFC HARRY E. CONRAD, of the Medical Nutrition Laboratory, Fitzsimons Army Hospital, Denver, Colorado, collaborated in the preparation of this article.

If a soldier gains weight during basic training, is this gain due to increase in body fat because of overeating or is it increase in muscle tissue due to physical training.

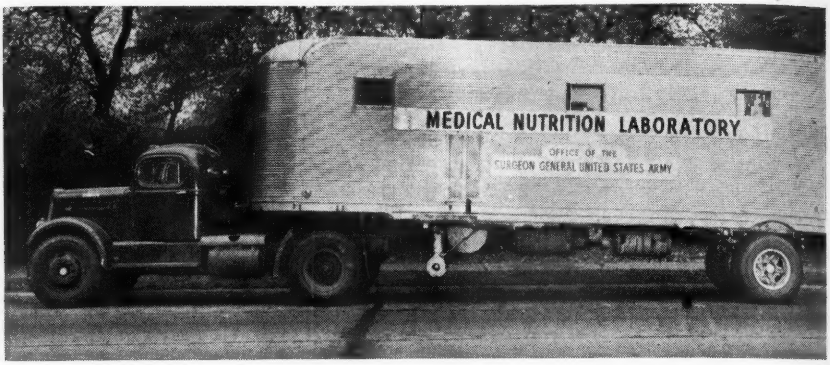
What are the optimum quantities of essential nutrients needed to promote recovery and rapid return to duty of soldiers suffering from disease, injury or starvation?

How can these nutrients best be provided in palatable form so that the soldier will consume them in adequate amounts, particularly in theaters of operations?

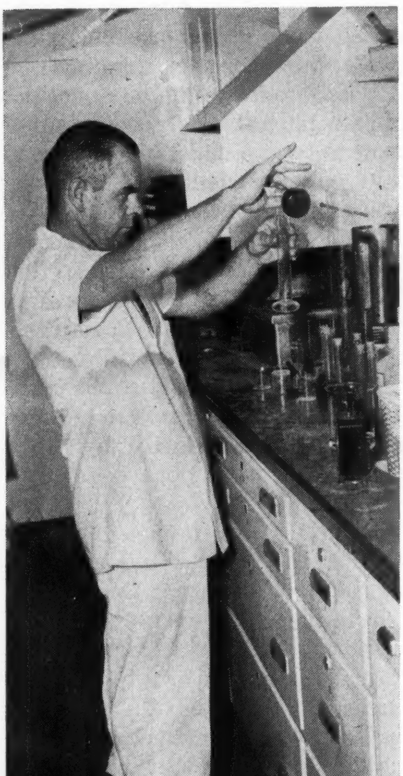
These are only a few of the problems confronting the Army in its program to provide the best food possible for its troops.

BESIDES his responsibility for the care of the sick and wounded as set forth in Army Regulations, The Surgeon General of the Army is responsible for determining the nutritional requirements for soldiers under all conditions of operation as well as the nutritional status of military personnel and civil populations under military control.

In discharging this responsibility it early became apparent that basic research was necessary to provide the answers to many of the prob-



A mobile laboratory, housed in this specially built 38-foot trailer, is used for making nutritional tests in the field.



Inside the trailer, a technician transfers solution to a graduated cylinder in an experiment.

lems which arose. Early in 1942 The Surgeon General established a small laboratory in the Nutrition Division of the Army Medical School at the Army Medical Center, Washington, D. C. Its purpose—to investigate Army rations in relation to the health of the soldier.

In 1944 the Laboratory, renamed the Medical Nutrition Laboratory, was moved to the Chicago Quartermaster Depot in close proximity to the Quartermaster Food and Container Institute for the Armed Forces. Thus medical specialists concerned with the physiological aspects of nutrition joined with food technologists to insure a comprehensive study of all types of nutrition problems.

As the Laboratory became more involved in experimentation with human subjects, it became advantageous to relocate the Laboratory at a major Army hospital, where both hospital and laboratory facilities could be utilized in investigat-

ing problems of human nutrition. Accordingly the Laboratory was moved to Fitzsimons Army Hospital in October 1953 where it is now functioning as a Class II activity.

AS PART of its mission, the Laboratory studies the nutrient intake of the soldier under various conditions in order to evaluate the adequacy of his diet. It assesses the health and performance capacity of troops in all environments to ascertain whether they are as well fed, as healthy and as fit as is compatible with local conditions. It develops and provides nutritional means for the prevention of disease or optimal recovery from disease and injury. It observes and makes recommendations on the nutrition of civil populations under military control. Finally, it conducts basic research in nutrition and metabolism directed toward fulfillment of these objectives.

Research activities are carried out by officers and civilian scientists having extensive experience in the field of nutrition. The Laboratory is now staffed by 18 officers, 46 enlisted men and 22 civilians. Officers include members of the Medical Corps, Medical Service Corps, Army Nurse Corps, and Women's Medical Specialist Corps. Many of the enlisted men have advanced degrees in nutrition, biochemistry, food technology or related fields.

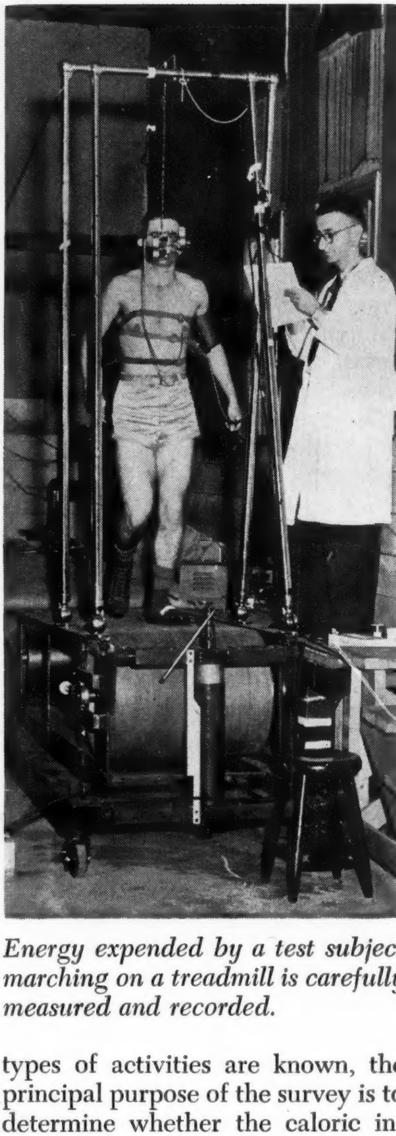
AMONG its activities, the Laboratory conducts surveys of the adequacy of nutrient intake in Army mess halls. To date, surveys have been made at six camps and five Army hospitals in areas representing a cross section of environmental conditions in the United States. Soldiers ranging from basic trainees to advanced infantry and paratrooper trainees are the subjects. In the hospital studies, patients on regular and special diets have been observed, as well as duty personnel of Army hospitals.

A typical survey actually begins months in advance of the tests. Methods are defined and the necessary equipment and supplies are ordered. By the time the survey begins, detailed plans have been formulated and coordinated, and Laboratory personnel have completed on-the-spot arrangements at the post to be surveyed.

Supplies are loaded into three truck-mounted laboratories and transported to the survey site. These specially designed mobile laboratories are equipped with water tanks and generators for use where regular water and electrical lines are not available. They augment the field laboratory which has been established in a conveniently located mess hall.

Troops selected for the survey are fed the Field Ration A as prescribed by the Army Master Menu. From this ration the soldiers may eat what they please and as much as they please. They may supplement their meals with food obtained at the Post Exchange or sent from home, provided that everything they eat is recorded in order that the extra calories may be included in the final calculations.

OBJECT of the survey is to determine whether the nutrients and calories consumed are adequate for the specific activity in which the soldier is engaged. Calories are important. Since approximate figures for energy expenditure in various



Energy expended by a test subject marching on a treadmill is carefully measured and recorded.

types of activities are known, the principal purpose of the survey is to determine whether the caloric intake per man is equal to his energy output or to the required caloric standards as prescribed by Army Regulations.

This may be done by any one of three methods—inventory, recipe, or chemical—used separately or in conjunction with each other.

The recipe method, while probably the most difficult, is also the most exact. All the ingredients used in preparing the various dishes are weighed and an accurate record is kept. The amount of food provided for each meal is determined, and any losses in preparation and plate wastes are deducted. By dividing the resulting figure by the head count, the amount of food eaten per man per meal is determined.

Specially prepared tables are utilized to ascertain the caloric content of the food actually eaten. As a variation of this method, a chemical analysis is made of a weighed composite meal sample to determine the caloric content.

No matter which method is chosen, a great amount of statistical data is required. The food must be weighed initially, and then a chemical analysis must be made. Samples must be quickly analyzed to avoid decomposition or dehydration.

SURVEYS of this type are only one of the many activities, projects and programs carried out by the six divisions of the Medical Nutrition Laboratory—Administrative, Nutrition Survey, Field Experiment, Physiology, Chemistry and Metabolic Research.

Administrative Division, in addition to normal duties, handles all statistical and graphic arts work related to the research, publication of laboratory reports and papers for scientific journals, and maintenance of a scientific library.

Nutrition Survey Division conducts periodic surveys of dietary intake, energy needs and nutritional status of military personnel under a variety of environmental conditions, using carefully evaluated clinical and laboratory procedures.

Field Experiment Division studies changes in physical fitness or the chemical makeup of the body induced by diet and environment. Actual vitamin levels in the body as compared with vitamin needs are determined under varying conditions of environmental and physical stress. Surveys of troops are conducted at Fort Churchill in Canada during the winter and at Yuma, Arizona, during the summer to evaluate the energy and nutrients required to perform various military tasks. This division also studies the changes in rate of metabolism and in hormone output with changing environment and activity.

Physiology Division is concerned with the physiological aspects of nutrition and metabolism, including the qualitative and quantitative changes taking place during vitamin deficiency, undernourishment, starvation, rehabilitation from wounds or disease, or intravenous feeding. Its pathology section examines tissues from individuals and animals suffering from malnutrition and starvation. The division also maintains an animal laboratory which is used in various research projects.

Chemistry Division investigates the chemical aspects of nutrition and metabolism. Some of the problems under study deal with biochemical changes in physical stress and disease; chemical changes and enzyme reactions in intermediary metabolism; decomposition of foods during treatment with X-rays or radioactive elements and the effects of feeding such foods to animals and man; and determination of mineral and vitamin requirements.

Metabolic Research Division is a comparatively new unit of the Laboratory. In its modern and well equipped Metabolic Ward as many as ten patients receive full-time medical, nursing and dietetic services while physiological and biochemical factors affecting metabolic balance are studied. Clinical problems in normal and abnormal metabolism are also investigated by this division.

FROM a small beginning, the Medical Nutrition Laboratory has developed into a modern, well organized research force for the advancement of scientific knowledge concerning nutrition as a vital aid in maintaining Army health.

Developed for war, nuclear energy helps the Army Medical Service in its constant

Battle Against Disease

Major Herschel J. Wells

THE WAGING of war, now as always, is not entirely confined to troops in the field. Today the Army Medical Service is using atomic age techniques in combatting the universal enemy, disease, on the hidden battlefields of the human body.

Radioactive elements, known as radioisotopes, are being employed daily as tactical weapons in this age-old crusade for cures. Even more important is the role that they are playing in the revision of old concepts and the development of new ones which shape the strategy of the crusade.

In any discussion of radioisotopes the average reader is apt to feel that the entire subject is too deeply scientific for him to understand. Actually a grasp of some of the principles involved in the medical uses of radioisotopes is not especially difficult and should help all Army personnel appreciate more fully how new developments in this field are contributing to maintenance of Army health.

SIMPLY stated, radioisotopes are elements which emit radiations. These radiations travel, like light rays from the sun, until they strike some form of matter which deflects or stops them. In the process of being deflected or stopped, changes are produced in the matter which they strike. The effects of some of these changes cannot be detected without great effort; in other instances the effects can be detected easily and are utilized readily for diagnostic studies.

One of the easily detected effects occurs when radiations emanating from radioisotopes strike the sensitive part of a radiation-detection instrument known as a Geiger-Muller counter—a tiny electrical impulse is initiated. This impulse is amplified and transmitted to an electronic device that translates it into a sound, such as the familiar click of the Geiger counter, or into a number on the dial of a register.

A similar sound or register effect can be produced when radiations strike a scintillation counter, in which the sensitive part is a man-made crystal. In the Geiger-Muller Counter the sensitive part is a gas-filled tube.

Such instruments can measure accurately small quantities of radiation so that it is possible to keep

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ordinary diagnostic doses of radioisotopes well within the limits which are considered safe.

Radioiodine, known as I^{131} to distinguish it from other isotopes of iodine, is the radioisotope most frequently used for diagnostic purposes. It is particularly useful in diagnosing diseases of the thyroid gland because this gland concentrates very large amounts of iodine, as compared with the rest of the body.

Concentration occurs because iodine is required by the thyroid gland for the production of thyroid hormone. In the process, the gland cannot distinguish radioiodine from ordinary iodine.

IT WAS long thought, and now has been demonstrated, that a measure of the amount of iodine concentrated by the thyroid is of value in the diagnosis of hyperthyroidism (production of excessive amounts of thyroid hormone) or its opposite, hypothyroidism.

Until recent years there was no direct way of measuring the amount of iodine in the thyroid gland of a living person. Today, however, by administering a dose of radioiodine and using extremely sensitive yet accurate radiation-detection instruments, the amount of radioiodine deposited within the thyroid gland can be estimated with a reasonable degree of accuracy.

One of the simplest of the many tests of thyroid function by this method begins when the patient drinks a cup of water containing the dose. Twenty-four hours later the amount of radioiodine in the gland is measured by placing a radiation-detection instrument several inches in front of the thyroid region of the patient's neck. A calculation of the percent of the dose concentrated by the gland then indicates whether it is overactive or underactive. The overactive gland concentrates a larger percentage of the dose than a normal one; the underactive thyroid gland concentrates a smaller percent of the dose.

A modification of this method is employed to determine the distribution of radioiodine within the thyroid gland as well as in thyroid tissue occurring elsewhere in the body. This is accomplished by encasing the radiation-detection instrument in a lead cylinder so that radiations can reach the sensitive part of the instrument from only one direction.

By moving the instrument from point to point over the body, the location of the radioiodine within the body can be determined much as a deposit of uranium is located by a prospector. Such localization studies are of value in the diagnosis of thyroid cancer inside the thyroid gland and in the detection of thyroid cancer tissue which has spread to other parts of the body.

Brain tumor localization studies are similar as far as the instruments and general procedure are concerned but depend upon the concentration of a different form of radioiodine. Certain materials to which atoms of radioiodine can be attached—including human serum albumen which is a normal constituent of blood, and certain dyes—are useful for such studies.

THE actual search for a tumor requires considerable time and patience since a large number of measurements must be carried out at many different points. However,

by proper application of this technique, it is possible to locate some tumors very precisely.

Similar techniques also have been developed for the diagnosis of gall-bladder disease. In general, a gall bladder which is functioning normally will concentrate the labelled dye, while one not functioning normally will not.

In another application of the principle of localization, radioiodine-labelled human serum albumen is injected into the cerebrospinal fluid space to help in detection of injuries and tumors of the spine or of the spinal cord.

A different type study with radioiodine-labelled human serum albumen can be used for certain blood volume determinations in sick and injured patients. The principle involved is known as isotopic dilution. Although rather complicated in its application, the basic principle is simple to understand.

IF A known amount of radioiodine (in the form of radioiodine-labelled human serum albumen) is injected into the bloodstream and allowed to remain until evenly mixed throughout the entire blood volume, then a quantity of blood can be withdrawn and the degree of radioiodine dilution measured.

Thus if a pint sample of blood is found to contain exactly one tenth of the radioiodine which was originally injected, it is evident that the entire volume in which the radioiodine was diluted was ten pints. Similarly, if the pint contains one fifth of the injected material, the entire volume in which the radioiodine was diluted was five pints. In actual practice, of course, only a small fraction of a pint is removed for the test.

Another study based on the dilution principle permits measurement of the total mass (also referred to as volume) of red blood cells. Red blood cells labelled with radiochromium (Cr^{51}) or radiophosphorous (P^{32}) are injected into the bloodstream of a patient. Time is allowed for mixing and then a sample of blood is removed. The total mass of red blood cells then can be calculated by the principle described above. Such studies offer much information concerning abnormal states such as the wound shock so frequently seen in combat casualties.

IN another important application, radiations from radioisotopes are used as a medium for exposing sensitized film. A newly developed portable x-ray machine now undergoing Army field tests utilizes radiothulium (Tm^{170}) as a source of radiation. In essence, this unit consists of a hollow metal container which holds the radiothulium and controls the radiations which it emits. In one side is a window which can be opened or closed by means of a shutter. When the window is opened the radiations emerge to expose the film. After a measured interval the invisible beam of radiations is stopped by closing the window. The entire unit is light enough to be carried by one man and requires no electrical power supply when utilized in the field. (See "First Aid Equipment," April 1955 DIGEST.)

In still another application of the film method, a specimen of tissue which contains a radioisotope is placed on unexposed film to produce a self-portrait known as a

radioautogram. Examination of the developed film permits precise localization of the radioisotopes which have been administered to study physiological processes.

A third application of this particular effect is employed in determining the extent of exposure of personnel to radiation. To accomplish this, film strips are placed inside badges which are worn by exposed individuals. The degree of darkening of the film is used to determine the amount of radiation to which the film—and therefore the wearer—has been exposed. These film badges are useful in detecting overexposure to radiation so that preventive measures can be instituted (See "Radiation Detection Instruments", this issue.)

RADIOISOTOPES are useful in the treatment of diseases for the same reason they are useful in diagnosis—because they emit radiation. Changes caused in tissues by radiations are similar to those caused in other matter, but the detectable effects are different.

Small amounts of radiations, as emitted by radioisotopes used in diagnosis, have no detectable effects on tissues. But larger amounts produce a sort of controlled destruction useful in treating certain diseases. Much larger amounts, never used for medical purposes, may cause such extensive destruction as to be fatal.

Treatment with radioisotopes can be accomplished either from within or outside the body. Best publicized of the latter type of use is the "cobalt bomb" which is used in treatment of certain cancers. The construction and operation of such a unit is basically the same as that of the radiothulium unit already described—but the powerful nature of the radiations involved require that the unit be considerably larger and much more elaborate.

Radioisotopes can be placed within the body to accomplish treatment in two ways. The first is basically similar to methods developed for use with radium. Examples include needles, seeds, solutions and the like, made from radiocobalt (Co^{60}) and radiogold (Au^{198}). These are implanted or injected directly into the tissues where treatment is desired.

The second method is unique, however, in that it requires only that the radioisotope be introduced into the body, usually orally or injected into the blood stream. The body itself distributes the radioisotope to the tissues where treatment is needed. A good example is the use of radioiodine in the treatment of hyperthyroidism. The thyroid gland concentrates the material which in turn reduces the activity of the gland.

TREATMENT of those types of thyroid states which concentrate radioiodine differs only in the size of the dose, more being required to treat cancer. As used in the Radioisotope Clinic at Walter Reed Army Medical Center, the average dose used to treat hyperthyroidism is about 500 times larger than the average diagnostic dose while the average for treatment of thyroid cancer is about 5000 times larger. This gives an idea of the great difference between doses administered for diagnosis and treatment.

Radiophosphorous (P^{32}) is another radioisotope which needs only to be introduced into the body to

reach the tissues to be treated. One of its major uses is in treating leukemia, a blood disease characterized by the over-production of white blood cells.

After the radiophosphorous solution is drunk or injected into the bloodstream, it is concentrated by cells throughout the body. Cells of the blood-forming tissues are quite sensitive to the radiations and are depressed so that over-production of white blood cells is lessened or temporarily stopped.

It should be emphasized that, as in other forms of cancer therapy, treatment with radioisotopes does not always result in cures in the sense that the disease state disappears and never recurs. However, many patients are being successfully relieved of their symptoms for varying periods of time.

ALL of these developments in the diagnostic and therapeutic use of radioisotopes which have been discussed, illustrate only some of the diversified approaches now being used in the war on disease.

AS THIS ISSUE WENT TO PRESS, two top-level appointments in the field of Army research and development were made by Secretary of the Army Wilber M. Brucker. William H. Martin, formerly Deputy Assistant Secretary of Defense for Applications Engineering, was appointed Director of Research and Development for the Army, and Lieutenant General James M. Gavin was named Chief of Research and Development.

In announcing the appointments, Secretary Brucker declared, ". . . research and development will henceforth be given the highest possible priority in our organization. The Director of Research and Development will be accorded the same degree of responsibility as that given to an Assistant Secretary and will have complete authority in this field, reporting directly to the Secretary of the Army. The Director will be in charge of all plans, implementation and financing of research and development projects Army-wide."

A resident of New Jersey, Mr. Martin holds degrees from Johns Hopkins University and from Massachusetts Institute of Technology. He formerly served as a vice president of Bell Telephone Laboratories, and since January 1954 had been Deputy Assistant Secretary of Defense for Applications Engineering.

Occupying the military counterpart of Mr. Martin's office, General Gavin will be responsible for planning, reviewing and implementing research and development within the Department of the Army. In addition, he will be responsible for coordination of such activities with the Department of Defense and the other Armed Services.

Prior to his present appointment, General Gavin had served as Deputy Chief of Staff for Plans and Research, as Assistant Chief of Staff, G-3 (Training), and as Commanding General of VII Corps in Germany. During World War II, he commanded the 82d Airborne Division.

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Safety First in Chemical Research

ON THE INVISIBLE front-line manned by soldier-scientists at the Army Chemical Corps center for biological warfare, Camp Detrick, Maryland, steady advances are being made in measures for detection and counterattack on disease-producing organisms. And although the handling of pathogenic substances is a routine occurrence at this Army installation, the possibility of a "misfire" has been minimized by elaborate safeguards.

Exposure to dangerous germs is an ever-present hazard in bacteriological research. Recognizing this, Chemical Corps scientists have devised many items of special equipment to eliminate the possibility of cross-infection and contamination by disease-carrying substances. An outstanding example is the safety cabinet.

Early in Camp Detrick's 12-year history, it was noted that such routine procedures as pipetting cultures or removing cotton stoppers from culture-containing test tubes released germ aerosols or sprays into the air.

As a safety measure, a special cabinet was developed. Patterned after the cabinets used by handlers of radioisotopes, the unit consists of a stainless steel enclosure with glass panels in the front. Arm -length rubber gloves extend inside the cabinet to enable the technician to manipulate objects. A current of fresh air sweeps aerosols away from the operator and through filters which remove all germs. Any contamination inside the cabinet is reduced by ultraviolet lamps.

Other Detrick-developed devices include special pipetting instruments, protective clothing with ventilated head hood, improved centrifuge safety cups, leakproof high-speed blendors, and slit-type air samplers that enable the operator to undertake various tests with safety. Many of these developments have been widely adopted by Government and commercial laboratories.

By means of numerous articles in scientific journals and a touring exhibit that is shown at scientific gatherings, knowledge of these safety developments is being brought to the attention of thousands of interested scientists. Thus in defending its personnel against hidden invaders, the Chemical Corps is helping to advance safety in research laboratories across the Nation.

For an inside view of the Safety Cabinet, see back cover.